

SUMMIT CAMPUS NEW MIDDLE SCHOOL AND HIGH SCHOOL

**Summit Bridge Road
Middletown, DE 19709**

BID PAC 2 CONFORMANCE SET



**Volume 3 [Divisions 21-34]
Date: May 22, 2026**

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SECTION 21 01 70

FIRE SUPPRESSION SPRINKLER AND STANDPIPE SYSTEMS

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. Codes and Standards listed below, apply to work indicated on the drawings and in the specifications.
 - 1. National Fire Protection Association (NFPA)
 - 2. Delaware State Fire Prevention Regulations (DSFPR)
 - 3. American National Standards Institute (ANSI)
 - 4. American Society for Testing Materials (ASTM)
 - 5. National Electrical Manufacturer's Association (NEMA)
 - 6. Underwriters' Laboratories (UL)

1.2 SUMMARY

- A. This Section includes fire-suppression sprinklers, piping, and equipment for the following building systems:
 - 1. Wet-pipe, fire-suppression sprinkler systems, including piping, valves, specialties and automatic sprinklers.
 - 2. Wet pipe, fire suppression standpipe system, including piping, hose valves, valves, and specialties.
 - 3. Contractor shall provide schedule and location of all fire hose valve cabinets on sprinkler drawings regardless of which trade procures or installs them.
- B. Additional work includes, but is not limited to the following:
 - 1. Obtain and pay for all permits, licenses, approvals, reviews, utility shutdowns, water flow testing, pressure tests and acceptance inspections.
 - 2. Pipe sleeves through floors, walls and structural elements of the building, set in coordinated locations. Penetrations created in fire rated walls and floors, shall have their smoke stopping and fire rating integrity restored with the use of fire tested, U.L. listed details, that have prior approval of the local Fire Prevention Bureau.
 - 3. All cutting, coring and patching of general construction as necessary for installation of the work specified.
 - 4. Coordinated working drawings and hydraulic calculations from water flow test data less than one year old; submit and obtain approval by the local Fire Prevention Bureau and Owner's Insurance Underwriter, and State Fire Marshal.
 - 5. Clean-up, on a daily basis, of all debris associated with the installation of this work, as necessary to maintain the premises in a broom swept condition.
 - 6. Testing, adjusting, retesting, re-adjusting as may be required to obtain system acceptance by the local Fire Prevention Bureau, Owner's Insurance Underwriter, State Fire Marshal and Owner's Representative. Fire Protection Contractor shall remain responsible for the fire protection systems until all approvals are obtained.
 - 7. Provide equipment manuals, record drawings, valve tag schedules and personnel instruction, prior to system turnover to the Owner.

8. Provide fire protection on all floors during construction, utilizing temporary standpipes or fire extinguishers, according to the requirements of the authority having jurisdiction.
9. Performance of all work specified in this Section shall be in compliance with the requirements of the Occupational Safety and Health Act and Construction Safety Standards.
- C. The work in this Section includes providing all labor, materials, specialty products testing and services for, and reasonably incidental to, the satisfactory completion of the Fire Protection systems, as indicated on the Contract Drawings, in the Specification Sections, and as required by the applicable Codes and Standards.
- D. The following related work is specified in other Divisions and Sections of the specification.
 1. Electrical power supply to water flow switches, tamper switches.
 2. Fire extinguishers and cabinets.
- E. Related Sections include the following:
 1. Division 26 Section "Fire Alarm Systems" for alarm devices not in this Section.
 2. Division 22 Section "General Provisions – Plumbing/Fire Protection
 3. Division 10 Section "Fire Protection Specialties" for cabinets and fire extinguishers.
 4. Division 7 Section "Fire Stopping"

1.3 DEFINITIONS AND INTERPERTATIONS

- A. Specific terminology used in the Design Drawings and Specifications shall have the following meanings;
 1. "Piping" includes pipe, fittings, flanges, valves, controls, hangers, supports, vents, drains and other customarily required items required in connection with the transfer of gases and fluids.
 2. "Install" includes unloading at the delivery point for the project and performing all tasks necessary to establish a secure mounting and correct operation, for items and assemblies furnished by other trades or the Owner.
 3. "Furnish" includes purchase and delivery to the project site, of items and assemblies, complete with every necessary appurtenance.
 4. "Provide" shall mean "Furnish and Install"
 5. "Concealed" when used in connection with the installation of piping, shall mean hidden from view behind chases, furred spaces, pipe shafts, or above suspended ceilings.
 6. "Concealed Spaces of Combustible Construction shall be as defined in NFPA#13, Section 8.15.1.
 7. "Contractor" shall mean the Fire Protection contractor and his vendors, fabricators or subcontractors.
 8. "Design Drawings" shall mean documents, including drawings and written specifications, prepared by the Architects and Engineers, to obtain building permits and competitive bid proposals from contractors, for construction of the specified fire protection systems.
 9. "Working Plans" shall mean documents, including calculations, drawings and material specifications prepared by the fire protection contractor, according to NFPA#13, for obtaining approval from the authority having jurisdiction, Owner's insurance underwriter, Architect/Engineer and the State Fire Marshal.
 10. "NPS" shall mean nominal pipe size, in inches.
 11. "CPVC" shall mean Chlorinated polyvinyl chloride plastic.
 12. "Owner" shall mean Appoquinimink School District.

13. "Architect" shall mean the Architect of Record as denoted in this package.
 14. "Engineer" shall mean the Engineer of Record as denoted in this package.
 15. "UL" means Underwriter's Laboratories
 16. "FM" means Factory Mutual.
 17. "Sprinkler System" shall mean piping and sprinklers under the individual control of a supervised control valve, with provisions for alarm annunciation, alarm testing and system drainage.
 18. "Standpipe" shall mean piping, valves, hose connections, and allied equipment with the hose connections located such that water can be discharged through attached hose and nozzles, for the purpose of extinguishing a fire, thereby protecting a building, structure, its contents, and the occupants.
 19. Reference applicable NFPA Standards for additional definitions that shall apply to work under this Section.
- B. The use of the Design Drawings and Specifications by the contractor, for Bid Proposal and Working Drawing preparation, shall include the following understandings:
1. The information included in the drawings and specifications is given as a guide only, to indicate general design feasibility and to show an acceptable arrangement of system zones, system types, sprinkler positions, main piping location and equipment layout.
 2. The design drawings utilize symbols and diagrams to indicate required work, representing only the sequence of items to be installed, which have no dimensional significance and do not indicate every required item to be provided. The work shall be installed in accordance with the diagrammatic intent expressed on the drawings, in conformity with the dimensions indicated on the final architectural and structural working drawings, and final equipment shop drawings. Information regarding general construction shall be derived only from the Architectural and Structural Design Drawings and Specifications.
 3. The drawings and specifications are complementary and are to be utilized together for a complete interpretation of the work intended. The higher capacity or standard shall be provided, where conflicts between the drawings and specifications, or conflicts within themselves, occur.
 4. The limitations of the language used on the drawings and specifications shall not be interpreted as meaning that accessories and appurtenances, required for completion of work, are to be excluded. The description of any item, on the drawings or in the specifications or both, requires the installation of all its necessary components for approved, satisfactory operation. These drawings do not indicate sprinkler head locations. The Contractor shall reference the architectural reflected ceiling plans. The intent is to establish an architecturally acceptable arrangement of sprinklers with other ceiling elements including lights, diffusers, speakers etc., to be repeated in similar areas. Provide sprinklers according to the NFPA#13 occupancy hazard classification and spacing rules, for unfinished ceiling area.
 5. Submission of a bid proposal requires the contractor to review all project documents and visit the construction site, to be thoroughly familiar with all requirements for the project, and identify in his bid, conditions that may affect the efficient and satisfactory performance of the work. Claims for additional compensation shall be denied if the above procedures are not followed and the disputed conditions may have been identified by the completion of these required tasks.
 6. The information shown on the design drawings and written in the specifications shall not be interpreted as to instruct the contractor to not follow the applicable codes or local amendments. Where the information provided is believed not to be in conformance with the

code requirements, the contractor shall notify the Architect and Engineer for clarification prior to the submission of his bid proposal.

7. References to providing sprinklers per the NFPA#13 Standard mandates that all building areas shall be provided with complete, full sprinkler protection, unless specific notation is made to the contrary on the drawings or in the specification.
8. References in this Specification to NFPA Standards as design and installation guidance of fire protection systems, invoke all of the Sections, Subsections, Exceptions and Advisory Provisions of the Standard that are applicable to the Project's requirements; they are hereby included in this Specification as if repeated in their entirety, and are referenced to convey the minimum acceptable performance and installation requirements acceptable.
9. All the referenced information and guidance for design noted prior shall also be used and adhered to in the design of the fire suppression standpipe systems. Fire suppression standpipe systems shall be designed and installed in accordance with NFPA 14 and the Delaware State Fire Prevention Regulations.

1.4 SPRINKLER SYSTEM PERFORMANCE REQUIREMENTS

- A. Design sprinkler system piping according to the following requirements and obtain approval from authorities having jurisdiction, Owner's insurance underwriter, Architect, Engineer and Fire Marshal. Refer to Section 1.7 QUALITY ASSURANCE, paragraph I., Working Plans and Hydraulic Calculations, and Section 3.1 PREPARATION WORKING OF PLANS, for additional system performance related design requirements.
- B. Design sprinkler system piping according to the following:
 1. Include 10 psi cushion pressure as a margin of safety in available water flow and pressure calculations.
 2. Include losses from point of connection to city water main, through water-service entrance, backflow preventer, sprinkler system piping, including all valves, fittings and devices.
 3. Maximum piping velocity shall be limited to 20 fps.
 4. Sprinkler Occupancy Hazard Classifications shall be as follows:
 - a. Classrooms, Art Rooms, Music Rooms, Multi-Purpose Room: Light Hazard
 - b. Offices, Corridors, Toilet rooms, Locker rooms, Public Areas, Cafeteria Seating Areas: Light Hazard
 - c. Building Service Areas, Kitchen, Janitor's Closets, Electrical and Telephone Equipment Rooms and Closets, Mechanical Equipment Rooms: Ordinary Hazard, Gp. 1.
 - d. General Storage Areas, Stage Loading Docks: Ordinary Hazard, Gp. 1.
 - e. Combustible construction and Combustible concealed spaces: Light Hazard.
 - f. All other occupancies and hazards not noted, shall be in accordance with NFPA.
 5. Minimum Density for Automatic-Sprinkler Piping Design shall be as follows:
 - a. Light Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area unless otherwise indicated on drawing data schedule.
 - b. Ordinary Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area unless otherwise indicated on drawing data schedule.
 - c. Ordinary Hazard, Group 2 Occupancy: 0.20 over 1,500 sq. ft. area unless otherwise indicated on drawing data schedule.
 - d. Combustible construction and Combustible concealed spaces: 0.10 gpm over 1500-sq. ft. area unless otherwise indicated on drawing data schedule.

- e. Special Occupancy Hazard: As determined by authorities having jurisdiction.
- f. For light and ordinary hazard occupancies, where the requirements of NFPA 13 are met, design are reduction for quick response sprinklers may be used.
- C. Components and Installation shall be capable of producing piping systems with 175-psig minimum working-pressure rating, unless otherwise indicated.

1.5 STANDPIPE SYSTEM PERFORMANCE REQUIREMENTS

- A. Design Class I horizontal fire standpipe system piping according to the following requirements and obtain approval from authorities having jurisdiction, Owner's insurance underwriter, Architect, Engineer, and Fire Marshal. Refer to Section 1.8 QUALITY ASSURANCE, Paragraph I, Working Plans and Hydraulic Calculations, and Section 3.1 PREPARATION WORKING OF PLANS, for additional system requirements related design requirements.
- B. Design fire standpipe system piping according to the following:
 - 1. Design shall be in accordance with NFPA 14 and the Delaware State Fire Protection Regulations/International Building Code.
 - 2. Include losses from the fire department connection, including all valves including hose valves, fittings, and devices.
 - 3. Maximum piping velocity shall be limited to 20 fps.
 - 4. Classification: Class I Horizontal Wet Standpipe supplied by the fire department at the system fire department connection.
 - 5. Minimum standpipe flow and pressure to be as follows:
 - a. A flow of 250 gpm at the three most hydraulically remote hose connections of the hydraulically most remote horizontal standpipe.
 - b. A minimum of 100 psi at the most remote hose valve while flowing system demand.
 - c. The system shall be hydraulically designed so that the required system pressure does not exceed 175 psi at any point in the system.
- C. Components and installation shall be capable of producing piping systems with 175-psig minimum working-pressure rating, unless otherwise indicated.

1.6 SUBMITTALS

- A. The contractor shall provide Submittals according to Section 220010, with all required drawings, calculations and product data for complete review of the proposed system installation submitted at the same time. Incomplete submittals shall be returned unreviewed. When resubmittals are required, all changes from the original submittal shall be clearly identified with revision triangles and clouds.
- B. Product Data shall be provided for the following:
 - 1. Pipe and fitting materials and methods of joining for sprinkler piping.
 - 2. Pipe hangers and supports.
 - 3. Valves, including specialty valves, accessories, and devices.
 - 4. Alarm devices. Include electrical data.
 - 5. Air compressors. Include electrical data.
 - 6. Fire department connections. Include type; number, size, and arrangement of inlets; caps and chains; size and direction of outlet; escutcheon and marking; and finish.
 - 7. Sprinklers, escutcheons, and guards. Include sprinkler flow characteristics, mounting, finish, and other pertinent data.

8. Fire stopping product materials and U.L. listed installation details for penetrations of fire-rated walls and floors.
 9. Fire hose station equipment including hose valves, hose adapters and hose cabinets.
 - C. Fire-Hydrant Flow Test has been executed for the project on 1/16/19 and data is recorded on the drawing.
 - D. Sprinkler and Standpipe Piping Drawings: Working plans and hydraulic calculations, shall be prepared according to NFPA #13 and NFPA #14, and submitted to the authorities having jurisdiction, Owner's insurance agent, Architect, Engineer, and State Fire Marshal for approval.
 - E. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA #13 and NFPA #14, including the "Contractor's Material and Test Certificate for Aboveground Piping" for each system.
 - F. Maintenance Data: shall be submitted for each type of sprinkler component and specialty, and included in the maintenance manuals, specified in Division 1.
 - G. Record Drawings: Refer to Division 1 for requirements. An up to date set of working drawings shall be kept at the site to record minor change in the intended system installation, as as-built conditions. Provide the required copies of final working drawings, corrected to show all as-built conditions, to the Owner, and the Owner's insurance agent upon completion of the project.
 - H. System Diagram and Operating Instructions: Provide at the completion of work, a color coded, neatly drawn small scale plan, mounted in a substantial glass enclosed frame, showing the locations of all sprinkler system control valves, auxiliary low point drains and inspector's test connections. Provide a minimum of two (2) copies of the current edition of NFPA#25, "Standard for the Inspection, Testing, and Maintenance of Water Based Fire Protection Systems".
 - I. Guarantee: The contractor shall submit a written guarantee of all materials and workmanship for a period of one (1) year, beginning at the date of final acceptance or beneficial use to the Owner, which includes emergency repair service for sprinkler systems, within four (4) hours, on a twenty-four (24) hour, seven (7) day a week basis, upon request for repair service by the Owner.
- 1.7 QUALITY ASSURANCE
- A. All materials, specialty products, equipment, methods of installation, and the application of materials and products in specific situations, shall be in strict accordance with the applicable requirements of NFPA #13 and NFPA #14, and have the prior approval of the authority having jurisdiction. All materials and equipment shall be U.L. labeled and/or F.M. approved, and installed in accordance with their listings.
 - B. Installer Qualifications: An experienced installer who has designed and installed fire-suppression systems similar to that indicated for this Project and obtained design approval and inspection approval from authorities having jurisdiction.
 - C. Manufacturer Qualifications: Firms whose equipment, specialties, and accessories are listed by product name and manufacturer in UL's and/or Fire Marshal's "Fire Protection Equipment Directory" and that comply with other requirements indicated.
 - D. Sprinkler Components: Listing/approval stamp, label, or other marking by a testing agency acceptable to authorities having jurisdiction.
 - E. Working Plans and Hydraulic Calculations
 1. Design the specified sprinkler systems and standpipe systems utilizing hydraulic calculations and indicate the intended installation of systems accurately on minimum 1/8" scale plans, with 1/4" scale details which include the following:
 - a. Building section/elevation details, with all necessary elevation data shown.

- b. Riser diagram of system water supply and backflow prevention.
 - c. All pipe lengths, diameters, fittings, hangers locations and details, earthquake bracing and restraints, valves and devices with piping details.
 - d. A site plan indicating project location, site elevations, north arrow, street intersections, Fire Department access lane(s), location of Fire Department connection(s), and size, material and location of public, and private fire water service mains and their appurtenances. The site plan shall be scaled or indicate dimensions and distances (of mains) and show location of water flow test(s).
 - e. Hydraulically most remote design area(s) with hydraulic nodes on plans corresponding to hydraulic calculations.
2. Provide hydraulic calculations utilizing Hazen-Williams formula for determining piping friction losses, to prove the intended design, according to the requirements NFPA#13 and NFPA #14, using "C" values therein, which include the following:
- a. Each type of pipe and joining method to be used, including weight, schedule, wall thickness, exact internal diameters, wall thicknesses and corrosion resistance ratio (CRR), for pipes other than Sch. 40.
 - b. The K-factor, orifice diameter, and minimum operating pressure required, for each flowing sprinkler in the hydraulically most remote area(s), according to the worst case requirements of either NFPA#13, NFPA #14, the local Fire Dept., or the appropriate approval/U.L. listing pressure required, to deliver the required minimum water distribution. Flows shall be calculated to the nearest 1/10 gallon.
 - c. Piping friction losses calculated to the nearest foot for all pipe lengths over (1) foot; all vertical lengths shall be included to show loss or gain of elevation pressures. Pressures shall be calculated to the nearest 1/100 psi.
 - d. Pressure losses for dry valves, deluge valves, backflow preventers etc., shall be clearly indicated as a device, and expressed as additional feet of pipe.
 - e. Velocity in all piping to be 20 feet per second or less. Velocity pressure may be ignored in hydraulic calculations.
 - f. Provide hydraulic calculations in an "easily reviewable" format, similar to the traditional NFPA#13 presentation, including the name of the hydraulic calculation program used, if applicable. The order of entry shall follow the flow of water from the most remote design sprinkler back to the riser, with flows added and subtracted at the cross main; order entry based upon only a sequential ordering of the node numbers, which could result in jumps from one pipe segment to a disjunct segment, is not "easily reviewable", and therefore is not an acceptable submittal format.
 - g. All notes in the hydraulic calculations corresponding to the calculated results shall be clearly identified on the plans, including the site plan.
- 1.8 EXTRA MATERIALS
- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Sprinkler Cabinets: Finished, wall-mounting steel cabinet and hinged cover, with space spare sprinklers plus sprinkler wrench. Include the minimum number of each type of sprinkler in the project, as required by NFPA #13.
- 1.9 LEAK DAMAGE
- A. The fire protection contractor shall be responsible during the installation and testing of the sprinkler and standpipe system(s), for damage to building, it's contents, the work of

other trades etc., caused by leaks or overflow from equipment, defective valves, disconnected or unplugged pipes, fittings etc., and shall pay for the repair or replacement of work or facilities damaged by such leaks.

PART 2 – PRODUCTS

2.1 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:
 - 1. Specialty Valves and Devices:
 - Vicatulic Company
 - Tyco Fire Suppression & Building Products
 - Reliable Automatic Sprinkler Co., Inc.
 - Viking Corp.
 - 2. Water-Flow Indicators and Supervisory Switches/and Electrical Bells:
 - Tyco Fire Suppression & Building Products
 - Potter Electric Signal Co.
 - Reliable Automatic Sprinkler Co., Inc.
 - Viking Corp.
 - 3. Sprinkler, Drain and Alarm Test Fittings:
 - Tyco Fire Suppression & Building Products
 - Fire-End and Croker Corp.
 - Victaulic Company
 - AFG Manufacturing
 - 4. Sprinkler, Branch-Line Test Fittings:
 - Elkhart Brass Mfg. Co., Inc.
 - Fire-End and Croker Corp.
 - Smith Industries, Inc.; Potter-Roemer Div.
 - AFG Manufacturing
 - 5. Sprinkler, Inspector's Test Fittings:
 - Fire-End and Croker Corp.
 - G/J Innovations, Inc.
 - Triple R Specialty of Ajax, Inc.
 - AFG Manufacturing
 - 6. Fire Department Connections:
 - Potter-Roemer
 - Elkhart Brass Mfg. Co., Inc.
 - Fire-End and Croker Corp.
 - Tyco Fire Suppression & Building Products
 - Guardian Fire Equipment, Inc.

- Reliable Automatic Sprinkler Co., Inc.
- 7. Sprinklers:
 - Tyco Fire Suppression & Building Products
 - Reliable Automatic Sprinkler Co., Inc.
 - Viking Corp.
 - Victaulic Company
- 8. Fire Dept. Hose Valves:
 - Potter-Roemer
 - Elkhart
 - Fire-End and Croker Corp.
 - Guardian Fire Equipment, Inc.
 - Fire Hose Valve Cabinets:
 - Potter-Roemer
 - Larsen
 - Guardian Fire Equipment, Inc.
 - Fire-End and Croker Corp.
- 9. Fire-Protection-Service Valves:
 - Tyco Fire Suppression & Building Products
 - Central Sprinkler Corp.
 - Nibco, Inc.
 - Stockham Valves & Fittings, Inc.
 - Victaulic Company
- 10. Keyed Couplings for Steel Piping: (Grooved Fittings)
 - Tyco Fire Suppression & Building Products
 - Victaulic Company
 - Viking Corp.
 - Anvil International Grulok
- 11. Fire Protection Backflow Prevention Valve Assemblies.
 - Ames Fire & Waterworks
 - Watts Regulator Company
 - Apollo Valves (Conbraco)
- 2.2 PIPING MATERIALS
 - A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials in specific fire protection services. All piping shall be permanently marked continuously along its length by the manufacturer, properly identifying the type of pipe. All fittings shall be stamped or embossed by the manufacturer, indicating the size, pressure rating, and U.L. listing or F.M. approval.

2.3 PIPES AND TUBES

- A. Standard-Weight Steel Pipe: ANSI/ASTM A 53, ASTM A 135, or ASTM A 795; Schedule 40 in NPS 6" and smaller, and Schedule 30 in NPS 8" and larger, may be joined with threads or cut-groove couplings and fittings, for pressures up to 300 psi.
- B. Schedule 30 Steel Pipe: ASTM A 135 or ASTM A 795, with wall thickness less than Schedule 40 and equal to or greater than Schedule 30, or ASTM A 795 and ASME B36, 10M, Schedule 30 wrought-steel pipe, may be joined by welding or roll-groove couplings and fittings, for pressures up to 300 psi.
- C. Schedule 10 Steel Pipe: ASTM A 135 Schedule 10 in NPS 5" and smaller and NFPA #13 specified wall thickness in NPS 6" to NPS 10", may be joined by welding or roll-groove couplings and fittings, for pressures up to 300 psi.
- D. UL Listed CPVC fire sprinkler pipe and fittings for fire sprinkler system piping 3" and smaller (not including standpipe systems). See specification Section 21 01 72 CPVC Sprinkler Piping (Basis of Design).
- E. "THINWALL," "XL" piping shall not be permitted on this project.

2.4 PIPE AND TUBE FITTINGS

- A. Cast-Iron Threaded Flanges: ASME B16.1.
- B. Cast-Iron Threaded Fittings: ASME B16.4.
- C. Malleable-Iron Threaded Fittings: ASME B16.3.
- D. Steel, Threaded Couplings: ASTM A 865.
- E. Steel Welding Fittings: ASTM A 234/A 234M, ASME B16.9, or ASME B16.11.
- F. Steel, Grooved-End Fittings: UL-listed and approved, ASTM A 47, malleable iron or ASTM A 536, ductile iron; with dimensions matching steel pipe and ends factory grooved according to AWWA C606.

2.5 JOINING MATERIALS

- A. Refer to Division 22 Section "Basic Mechanical Materials and Methods" for pipe-flange gasket materials and welding filler metals.
- B. Steel, Keyed Couplings: UL 213 and AWWA C606, for steel-pipe dimensions. Include ASTM A 536, ductile-iron housing, rubber gaskets, and steel bolts and nuts. Include listing for dry-pipe service for couplings for dry piping.

2.6 FIRE-PROTECTION-SERVICE VALVES

- A. General: UL listed and approved, with minimum 175-psig nonshock working-pressure rating. Valves for grooved-end piping may be furnished with grooved ends instead of type of ends specified.
- B. Gate Valves, NPS 6" and Smaller: UL 262; cast-bronze, threaded ends; solid wedge; OS&Y; and rising stem.
- C. Indicating Valves, NPS 3" and Smaller: UL 1091; butterfly or ball-type, bronze body with threaded ends; and integral indicating device.
Indicator: Visual.
Indicator: Electrical 115-V ac, prewired, two-circuit, supervisory switch.
- D. (Optional Section) Gate Valves, NPS 4" and Larger: UL 262, iron body, bronze mounted, taper wedge, OS&Y, and rising stem. Include replaceable, bronze, wedge facing rings and flanged ends.

- E. Swing Check Valves, **NPS 2"** and Smaller: UL 312 or MSS SP-80, Class 150; bronze body with bronze disc and threaded ends.
- F. Swing Check Valves, **NPS 2-1/2"** and Larger: UL 312, cast-iron body and bolted cap, with bronze disc or cast-iron disc with bronze-disc ring and flanged ends.
- G. Split-Clapper Check Valves, **NPS 4"** and Larger: UL 312, cast-iron body with rubber seal, bronze-alloy discs, and stainless-steel spring and hinge pin.

2.7 SPRINKLERS

- A. Utilize quick-response sprinklers throughout Light and Ordinary Hazard occupancies
- B. Automatic Sprinklers: shall have heat-responsive element complying with the following:
UL 199, for applications except residential.
UL 1767, for early suppression, fast-response applications.
- C. Sprinkler Types and Categories: Nominal **1/2-inch** standard orifice, unless otherwise indicated or required by application.
- D. Sprinkler types, features, and options include the following:
Dry upright sprinklers
Dry pendent sprinklers
Horizontal Dry/Sidewall sprinklers
Pendent sprinklers (Recessed)
Quick-response sprinklers
Sidewall sprinklers
Upright sprinklers
- E. Sprinkler Finishes: Upright bronze, and "white" painted pendants and sidewalls.
- F. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
Ceiling Mounting: White-plated steel, two piece, flat.
Ceiling Mounting: Metal, white finish, two piece, flat.
Sidewall Mounting: White-plated steel, two piece, flat.
Sidewall Mounting: Metal, white finish, two piece, flat.
- G. Sprinkler Guards: Wire-cage type, including fastening device for attaching to sprinkler.
- H. Sprinkler Water Shields: Shield for protecting sprinkler, heat-sensing operating element from other sprinkler water discharge (pendent and/or upright sprinkler water shield).

2.8 SPECIALTY SPRINKLER FITTINGS

- A. Specialty Fittings: UL listed and approved; made of steel, ductile iron, or other materials compatible with piping.
- B. Locking-Lug Fittings: UL 213, ductile-iron body with locking-lug ends.
- C. Mechanical-T Fittings: UL 213, ductile-iron housing with pressure-responsive gasket, bolts, and threaded or locking-lug outlet.
- D. Mechanical-Cross Fittings: UL 213, ductile-iron housing with pressure-responsive gaskets, bolts, and threaded or locking-lug outlets.
- E. Drop-Nipple Fittings: UL 1474, with threaded inlet, threaded outlet, and seals; adjustable.

- F. Sprinkler, Drain and Alarm Test Fittings: UL-listed, cast- or ductile-iron body; with threaded inlet and outlet, test valve, and orifice and sight glass.
- G. Sprinkler, Branch-Line Test Fittings: UL-listed, brass body; with threaded inlet and capped drain outlet and threaded outlet for sprinkler.
- H. Sprinkler, Inspector's Test Fittings: UL-listed, cast- or ductile-iron housing; with threaded inlet and drain outlet and sight glass.

2.9 FIRE DEPARTMENT CONNECTIONS

- A. Confirm with the local Fire Department for type of connection requirement: Storz or Siamese.
- B. Wall, Fire Department Connections: UL 405; cast-brass body with brass, wall, escutcheon plate; brass, lugged caps with gaskets and brass chains; and brass, lugged swivel connections. Include inlets with threads according to NFPA 1963 and matching local fire department sizes and threads, outlet with pipe threads, extension pipe nipples, check devices or clappers for inlets, and escutcheon plate with marking "AUTO SPKR"/"STANDPIPE AND AUTO SPKR".

Type: Flush mounting.

Escutcheon Plate: Rectangular.

Finish: Polished chrome-plated.

2.10 ALARM DEVICES

- A. General: All alarm devices shall be U.L. listed and F.M. approved as sprinkler system attachments. Types utilized shall match piping and equipment connections.
- B. Electric-Operated Alarms: Provide 10" outside waterproof vibrating type bell and 6" inside bell, in locations shown on drawings or required by the local Fire Dept.
- C. Water-Flow Indicators: UL 346; electrical-supervision, vane-type water-flow detector; with 250-psig pressure rating; and designed for horizontal or vertical installation. Include two single-pole, double-throw, circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
- D. Pressure Switches: UL 753; electrical-supervision-type, water-flow switch with retard feature. Include single-pole, double-throw, normally closed contacts and design that operates on rising pressure and signals water flow.
- E. Valve Supervisory Switches: UL 753; electrical; single-pole, double throw; with normally closed contacts. Include design that signals controlled valve is in other than fully open position.
- F. Low Temperature Supervisory Switch: UL listed, electrical-supervisory-type, temperature activated, normally open contact, operated at set temperature of 40°F.

2.11 PRESSURE GAGES

- A. Pressure Gages: UL 393, 3-1/2- to 4-1/2-inch diameter dial with dial range of 0 to 250 psig.
- 2.12 See Specification Section 21 01 72 Alternate CPVC Sprinkler System Piping for alternative sprinkler piping material and fittings for wet-pipe, light hazard occupancy sprinkler pipe 3" or smaller.

PART 3 – EXECUTION

3.1 PREPARATION OF WORKING PLANS

- A. The contractor shall be responsible for reviewing the Architectural and Structural Design Drawings and verifying with the General Contractor, that substitutions of noncombustible building materials with combustible building materials have not been made that alter the requirements of the sprinkler system shown on the Fire Protection Design Drawings. Report such

substitutions to the Architect and Engineer for review, prior to the design of sprinkler systems. Combustible framing or construction is not allowed above ceilings, below floors or in concealed spaces, unless specifically protected by sprinklers.

- B. The final arrangement, positions and connections of pipes, drains, valves, sprinklers etc., shall be established by the fire protection contractor's design, and shall be configured to drain fully, avoiding trapped piping sections and excessive auxiliary drains. Sprinkler systems shall be installed concealed above architectural suspended ceilings where ceilings are provided, unless indicated otherwise.
- C. Design the specified fire protection systems from the fire service entry riser, in accordance with the mandatory requirements and all advisory provisions of NFPA#13 and NFPA#14, the requirements of the authority having jurisdiction and the Owner's insurance agent, utilizing hydraulic calculations, with uniform water distribution over each most remote design area and/or specified demand.
- D. Establish each sprinkler position, giving full consideration to the vertical and horizontal obstructions to sprinkler spray pattern development that may be presented by building construction, ductwork, mechanical and electrical equipment, piping, soffits and ceilings constructed with different adjacent elevations, suspended and surface mounted lighting fixtures etc.; coordinate the position and location of sprinklers, piping and system components, referencing the detailed working drawings of all other trades, to avoid installation conflicts.
- E. Contractor shall be responsible for planning and providing the required penetrations of fire rated walls, floors and smoke partitions, in such a manner that U.L. listed details that restore their fire rating integrity and that have prior approval of the Delaware State Fire Marshal's Office where they are utilized.
- F. Where practical, uniformly space sprinklers on branchlines; sprinklers shall be spaced in architectural patterns consistent with symmetrical positions of lights, air diffusers, speakers, and other ceiling elements, where sprinklers are shown on architectural reflected ceiling grid plans.
 - 1. Pendent sprinklers in architectural ceilings shall be centered in square ceiling tiles in both directions, and centered in the short dimension of rectangular tiles, with sprinkler positions acceptable at quarter points of the long dimension, +/- 12".
 - 2. Provide sprinkler spacing and locations per NFPA#13 requirements, in areas without suspended ceilings.
- G. Wet sprinkler systems may be "tree", "loop" or "grid" type systems, as may be hydraulically advantageous, unless a specific piping arrangement is indicated on the design drawings. System piping arrangement shall be configured above the top of recessed lighting fixtures, within suspended ceilings.
- H. Where sprinkler piping within concealed spaces provides protection for occupancies below, sprinklers for protection of concealed spaces may be attached to the same piping system. Hydraulically calculate each set of sprinklers separately and provide pipe sizes for the hydraulically more demanding group.
- I. Sprinklers for the protection of attic spaces may be conventional upright or pendent types, or a combination of these types of sprinklers. The position of sprinklers in attics framed of combustible construction, shall establish sprinkler protection into the eaves overhanging the outside of the building.
- J. Provide sprinkler protection in combustible framed, horizontal and vertical soffits and wall cavities, with outside finished dimensions greater than 14." Where combustible concealed construction and spaces are permitted to be unsprinklered, meeting one or more of the exceptions of NFPA#13, Section 8.15.1.1, the design area of application shall be increased to a minimum of

3,000 sq.ft., without revising the hydraulic density, per NFPA#13, Section 11.2.3.1.5 and 11.2.3.2.

- K. Provide standpipe system hose connections at all locations as required by NFPA #14, the Delaware State Fire Prevention Regulations, the Authority having Jurisdiction and thoughts locations as directed by the Owner, Architects, and/or the Engineer. Provide hose valve cabinets in locations as indicated on the Architectural and Design drawings.

3.2 PIPING APPLICATIONS

- A. Flanges, unions, transitions and special fittings shall have pressure ratings the same as or higher than system's static pressure rating for use in aboveground applications, unless otherwise indicated.
- B. Piping between Fire Department Connections and Check Valves: Use galvanized, standard-weight steel pipe with grooved ends; steel, grooved-end fittings; steel, keyed couplings; and grooved joints.
- C. Underground Service-Entrance Piping: Use ductile-iron, push-on-joint pipe and fittings and restrained joints.

Fire Suppression Bulk Mains and Risers: See Fire Protection Drawings.

- D. Wet-Pipe Sprinkler Branch and Standpipe Piping: See Fire Protection Drawings.
 - 1. NPS 2-1/2" and Larger: Standard weight (Schedule 10) steel pipe with roll-grooved ends; steel, grooved-end fittings; and grooved couplings.
 - 2. NPS 2" and Smaller: Standard-weight steel pipe with threaded ends, cast- or malleable-iron threaded fittings, and threaded joints.
- E. Drypipe Sprinkler Branch Piping: See Fire Protection Drawings.
 - 1. NPS 2-1/2" and larger: Standard weight, hot dipped galvanized steel pipe with grooved ends, steel grooved-end fittings and grooved couplings.
 - 2. NPS 2" and smaller: Standard weight, hot dipped galvanized, steel pipe with threaded ends, cast or malleable iron, threaded fittings and threaded joints.

3.3 VALVE APPLICATIONS

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Fire-Protection-Service Valves: UL listed and approved for applications where required by NFPA#13.
Shutoff Duty: Use gate and/or butterfly valves.
 - 2. General-Duty Valves: For applications where UL-listed and approved valves are not required by NFPA #13.
Shutoff Duty: Use gate, ball, or butterfly valves.

3.4 JOINT CONSTRUCTION

- A. Refer to Division 22 Section "Basic Mechanical Materials and Methods" for basic piping joint construction. Apply joint compound or tape to male threads only.
- B. Steel-Piping, Grooved Joints: Use Schedule 40 steel pipe with cut or roll-grooved ends and Schedule 30 or thinner steel pipe with only roll-grooved ends; steel, grooved-end fittings; and steel, keyed couplings. Assemble joints with couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions. Use gaskets listed for dry-pipe service for dry piping.
- C. Locking-Lug-Fitting, Twist-Locked Joints: Follow fitting manufacturer's written instructions.

- D. Dissimilar-Piping-Material Joints: Construct joints using adapters or couplings compatible with both piping materials. Use dielectric fittings if both piping materials are metal. Refer to Division 22 Section "Basic Mechanical Materials and Methods" for dielectric fittings.

3.5 WATER-SUPPLY CONNECTION

- A. Connect sprinkler piping to the 12" stubbed-up flanged outlet connection provided by the Plumbing Contractor.
- B. Install shutoff valve, backflow preventer, riser check valve assembly, pressure gage, drain, and other accessories indicated at connection. The backflow preventer shall be UL listed for fire protection service. Backflow preventer for this project shall be AMES 3000 "Silver Bullet."

3.6 PIPING INSTALLATION

- A. Refer to Division 22 Section "Basic Mechanical Materials and Methods" for basic piping installation.
- B. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
 - 1. Deviations from approved working plans for piping installation require written approval from authorities having jurisdiction. File copy of written approval with Architect before deviating from approved working plans.
- C. Use only approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes. Bushings shall not be used.
- D. Install flanges or flange adapters on valves, apparatus, and equipment having NPS 2-1/2 and larger connections. Not required on grooved connections.
- E. Install "Inspector's Test Connections" for each sprinkler system, sized and located according to NFPA #13 requirements. Install main drain test connection at location that will permit full flow discharge for a time sufficient to allow for proper testing of water supplies, without flooding or water damage.
- F. Install sprinkler piping to avoid excessive auxiliary drains. Provide auxiliary drains as required for complete drainage of trapped piping sections.
- G. Install sprinkler zone control valves, test assemblies, and drain risers adjacent to sprinkler risers when sprinkler branch piping is connected to sprinkler risers.
- H. Install ball drip valves to drain piping between fire department connections and check valves. Drain ball drips to floor drain or outside building.
- I. Install alarm devices in piping systems.
- J. Hangers and Supports: Comply with NFPA #13 for hanger materials and installation. Hangers, hanger rods and attachments must be capable of supporting five (5) times the weight of the water-filled pipe, plus 250 pounds minimum, at each point of hanging. Piping shall be supported from building structure only, and shall not be hung from ductwork, conduit runs or other piping. Install piping straight and true, parallel with building walls, without dips or sags. Piping shall bear evenly on all pipe hangers. Provide complete details of earthquake bracing and flexible couplings consistent with the requirements of the seismic zone of the project location.
- K. Install piping with grooved joints according to manufacturer's written instructions. Construct rigid piping joints, unless otherwise indicated.
- L. Install pressure gages on system risers and at each sprinkler test connection. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.

- M. All hangers, anchors, support and guides for piping, and equipment shall be securely fastened to the building structure and/or floors with concrete decking with the following exception. Hangers, anchors, support and guides shall not be fastened to or through metal roof decking (i.e. bare metal decking or metal deck supporting a roofing system).

3.7 SPECIALTY SPRINKLER FITTING INSTALLATION

- A. Install specialty sprinkler fittings according to manufacturer's written instructions.

3.8 VALVE INSTALLATION

- A. Refer to Division 22 Section "Valves" for installing general-duty valves. Install fire-protection specialty valves, trim, fittings, controls, and specialties according to NFPA #13, manufacturer's written instructions, and authorities having jurisdiction.
- B. Gate/Butterfly/Valves: Install fire-protection-service valves supervised-open, unless noted otherwise, located to sectionalize system and control sources of water supply, except from fire department connections. All sectional control valves shall be installed in accessible locations.
 - 1. Provide drains at all sectional control valves. Pipe drains to an acceptable location, capable of accepting full flow discharge without flooding or damage. Provide permanent identification signs indicating portion of system controlled by each valve, according to NFPA#13 requirements.
- C. Install check valve in each water-supply connection. Install UL listed fire protection backflow preventers instead of check valves in potable-water supply sources.
- D. Riser Check Valves: Install valves in vertical position unless noted otherwise, for proper direction of flow.
- E. Install standpipe hose valves at all locations as required by NFPA 14, NFPA 101, the Delaware State Fire Prevention Regulations and where indicated on the drawings. Installation shall be in accordance with NFPA 14.

3.9 SPRINKLER APPLICATIONS

- A. General: Only new sprinklers shall be installed, according to their listing requirements. Ornamental finishes shall be factory applied only. Position sprinkler deflectors at the same elevation, parallel with ceiling plane.
- B. Use sprinklers according to the following applications:
 - 1. Rooms without Ceilings: Upright sprinklers.
 - 2. Rooms with Suspended Ceilings: Recessed Pendent, sprinklers.
 - 3. Wall Mounting: Sidewall sprinklers.
 - 4. Spaces Subject to Freezing: Upright; pendent, dry-type; and sidewall, dry-type sprinklers.
 - 5. Special Applications: Use quick-response sprinklers where indicated.
 - 6. Sprinkler Finishes: Use sprinklers with the following finishes:
 - a. Upright, Pendent, and Sidewall Sprinklers: White-plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

3.10 SPRINKLER INSTALLATION

- A. Install sprinklers in patterns indicated. Install sprinklers in suspended ceilings in center of acoustical panels and tiles.
 - 1. Install sprinklers in suspended ceilings in center of narrow dimension of acoustical panels, and quarter points of the long dimension.

- B. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing. Use dry-type sprinklers with water supply from heated space,
- C. Install approved sprinkler guards at all sprinklers installed below 7'-6", or where mechanical damage is possible.
- D. Install sprinklers in accordance with manufacturer's requirements.

3.11 CONNECTIONS

- A. Install ball drip valves at each check valve for fire department connection. Route drain pipe to floor drain or outside building.
- B. Connect piping to specialty valves, specialties, fire department connections, and accessories.
- C. Connect alarm devices to sprinkler systems.

3.12 LABELING AND IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA #13, Division 22 Section "Basic Mechanical Materials and Methods", and the Delaware State Fire Prevention Regulations.

3.13 FIELD QUALITY CONTROL

- A. Provide a flanged spool section of pipe and a temporary conical type strainer on the incoming fire protection water service, before the building fire protection and sprinkler system equipment (backflow preventer, fire pump, etc.), for the fire protection system during installation. Prior to the final commissioning, remove the strainer and reinstall flanged spool section.
- B. Flush, test, and inspect sprinkler piping according to NFPA #13, "System Acceptance" Chapter.
- C. Replace piping system components that do not pass test procedures and retest to demonstrate compliance. Repeat procedure until satisfactory results are obtained.
- D. Report test results promptly and in writing to Architect and authorities having jurisdiction.

3.14 CLEANING

- A. Clean dirt and debris from sprinklers, remove protective covers used during painting.
- B. Remove and replace sprinklers having paint other than factory finish.

3.15 PROTECTION

- A. Protect sprinklers from damage until Substantial Completion.

3.16 COMMISSIONING

- A. Verify that specialty valves, trim, fittings, controls, and accessories are installed and operate correctly.
- B. Verify that specified tests of piping are complete.
- C. Verify that damaged sprinklers and sprinklers with paint or coating not specified are replaced with new, correct type.
- D. Verify that sprinklers are correct types, have correct finishes and temperature ratings, and have guards as required for each application.
- E. Verify that fire department connections have threads compatible with local fire department equipment.
- F. Fill wet-pipe sprinkler piping with water.
- G. Adjust operating controls and pressure settings.
- H. Coordinate with fire alarm tests. Operate alarm devices with water, as required to demonstrate proper function.

- I. Provide a flow test for record on the site fire hydrants nearest the building regardless of the previous date. Data to be included below.
- J. Provide an 8-1/2" x 11" drawing in "pdf" format for the Owner, Local Fire Department and the Fire Marshal's Office. Data required on drawing shall indicate the following:
 - 1. Name, address and location of the building.
 - 2. The location of all fire suppression system control valves.
 - 3. The location of all fire department connections for all fire suppression systems.
 - 4. The location of the fire alarm control pane and annunciation panel.
 - 5. The location of all site fire hydrants.
 - 6. Main entrance and exits.
 - 7. Name, and telephone numbers of responsible personnel for responding during emergencies.

3.17 SYSTEMS ACCEPTANCE AND TESTING

- A. Notify the Authority Having Jurisdiction, the Owner's representative, and Architect and Engineer of time and date of scheduled testing. Provide minimum of 5-day prior notice of testing to allow for witnessing.
- B. Perform all required system testing and acceptance requirements on the new (and modified) system installations in accordance with NFPA 13, 14, & 25, the Delaware State Fire Prevention Regulations, the Authorities Having Jurisdiction (AHJ) requirements and all other local codes and ordinances. At a minimum provide the following:
 - 1. Perform all acceptance requirements per the codes; pipe flushing, inspections, etc.
 - 2. Perform all operational and functional tests of systems and equipment required by the codes and equipment manufacturers.
 - 3. Perform hydronstatic pressure test on new (and modified) above ground systems piping in accordance with NFPA 13. New system shall be tested to 50 psi over normal system working pressure (minimum 200 psi) for 2 hours without leaks.
- C. Provide all required reports, records and documentation, to the owner, engineer and authority having jurisdiction prior to or at the completion of the project. At a minimum provide the following:
 - 1. Completed and signed "Contractor's Material and Test Certificate for Aboveground Piping" for each system.
- D. Prior to placing systems in final service, provide a final inspection of new and/or modified systems to ensure item such as protective caps & straples have been removed or put in place, escutcheons have been install, penetrations seals have been provided, ceiling tiles have been replaced, etc.

3.18 DEMONSTRATION

- A. Demonstrate equipment, specialties, and accessories. Review operating and maintenance information.
- B. Schedule demonstration with Owner with at least seven days' advance notice.

END OF SECTION

SECTION 21 01 71
FIRE PUMP – ELECTRIC**PART 1 – GENERAL****1.1 RELATED DOCUMENTS**

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the work specified in this Section.

1.2 DESCRIPTION OF WORK

- A. This Section shall include all work necessary and/or required and furnish all materials and equipment for construction of a complete automatic fire pump system for the building. Such work includes but is not limited to the following:

- 1. Furnish and install where shown on plans a vertical in-line Aurora Fire Pump System complete with pump, electric motor driver, controller and accessories. The pumping unit shall be listed by Underwriters' Laboratories, Inc. and/or shall be fully approved by the Associated Factory Mutual Fire Insurance Companies, where applicable. The pumping unit shall meet all requirements of the National Fire Protection Association Pamphlet No.20. The Fire Pump shall be designed to deliver 500 G.P.M. when operating at 60 PSIG. The pump shall also deliver not less than 150% of rated capacity at a pressure not less than 65% of rated pressure. The shut off pressure shall not exceed 140% of rated pressure. Suction pressure is 62 PSIG. The pump shall operate at a maximum synchronous speed of 3500 R.P.M.
- 2. Include all associated valves, piping and equipment so that the fire pump will function as a unit in compliance with NFPA 20. The fire pump piping arrangement will include a water supply bypass arrangement.
- 3. Included in this section:
 - Fire Pump and Driver Package
 - Electric Jockey Pump
 - Related Controllers
 - Fire Pump Accessories

1.3 REFERENCE STANDARDS

- A. Refer to Section 210000 for a general description of requirements applying to this section.
- B. NFPA 20: Installation of Centrifugal Fire Pumps.
- C. NFPA 70: National Electric Code
- D. UL: Fire Protection Equipment Directory.
- E. UL 448: Pumps for Fire Protection Service
- F. UL 1478: Fire Pump Relief Valves
- G. UL1004-5: Standard for Fire Pump Motors

1.4 QUALITY ASSURANCE

- A. Refer to Section 220010 and 210170 for a general description of requirements applying to this section.
- B. Contractor shall provide new and complete fire pump system in satisfactory operating condition which shall conform to requirements of the following:
 - 1. NFPA Pamphlet 20

2. Delaware State Fire Marshal's Office
 3. Owner's Insurance Agency
- C. Submit working drawings to the Fire Marshal's Office and obtain approval before beginning work.
- 1.5 SUBMITTALS
 - A. Submit shop drawings and product data in accordance with Section 220000.
 - B. Submit shop drawings with Fire Marshal's approval and descriptive data, complete with product designation for the following:
 1. Pump layout
 2. Associated piping and equipment
 3. Dimensional data
 4. Weights
 5. Clearances
 6. Method of assembly
 - C. Submit complete pump layout indicating location of fire pump by dimensions from walls, pipe size, and locations of valves, and accessories, with Fire Marshal approval.
 - D. Product Data: Provide manufacturer's literature including general assembly, pump curves showing performance characteristics with pump and system, operating point indicated, NPSH curve, controls, wiring diagrams, and service connections.
 - E. Manufacturer's Installation Instruction: Include start-up instructions for the fire pump.
 - F. Manufacturer's Certificate: Certify that fire pump meet or exceed specified requirements at specified operating conditions.
 - G. Field Reports: Indicate summary of hydrostatic test and field acceptance tests performed in accordance with NFPA 20.
- 1.6 OPERATION AND MAINTENANCE DATA
 - A. Operation Data: Include manufacturer's instructions, start-up data, and trouble-shooting checklists for pumps and controllers.
 - B. Maintenance Data: Include manufacturer's literature, cleaning procedures, replacement parts lists, and repair data for pumps, drivers and controllers.
- 1.7 WARRANTY/GUARANTEE
 - A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, GENERAL REQUIREMENTS.
- 1.8 DELIVERY, STORAGE AND HANDLING
 - A. Accept fire pumps and components at site in factory packing. Inspect for damage. Comply with manufacturer's rigging and installation instructions.
 - B. Protect fire pump and components from physical damage, including effects of weather, water and construction debris.
 - C. Provide temporary inlet and outlet caps, and maintain in place until installation.
- 1.9 MAINTENANCE SERVICE
 - A. Furnish service and maintenance of fire pump, driver and controller for one year from date of substantial completion.
 - B. Furnish service and maintenance of jockey pump, driver and controller for one year from date of substantial completion.

PART 2 – PRODUCTS**2.1 MANUFACTURERS**

- A. Subject to compliance with specification requirements, manufacturers offering fire pump system equipment shall be limited to the following:
1. Centrifugal Pump (Main Pump)
 - Aurora (Basis of Design)
 - Patterson
 - Fairbanks
 - AC Fire Pump
 2. Controller
 - Tornatech (Basis of Design)
 - Firetrol
 - Metron
 3. Jockey Pump
 - Aurora (Basis of Design)
 - Grundfos
- B. Manufacturers identified above shall be selected for this project only as required from Owner's standardization list. No other manufacturers shall be permitted.

2.2 VERTICAL BASE MOUNTED INLINE PUMP

- A. The fire pump shall be Aurora 383 vertical inline mounted size 4-383-7B bronze fitted, single stage, centrifugal pump, or approved equal.
- B. The driver shall be a vertical, open drip-proof (or T.E.F.C.), ball bearing type, AC, induction, squirrel cage "P" face motor: 25 HP maximum, 3560 RPM vertical shaft wound for 460 volts, 3 phase, 60 Hertz. The motor shall be of such capacity that 115% of the full-load ampere rating shall not be exceeded at any condition of pump load. Locked rotor current shall not exceed the values specified in NFPA Pamphlet No.20.
- C. The pump shall be fitted with Teflon lantern ring when the suction pressure is 30 psi or less.
- D. Casings shall be of cast iron having a minimum tensile strength of 35,000 P.S.I. Bearing housing supports, and suction and discharge flanges shall be integrally cast with the lower half of the casing. Removal of the upper half of the casing must allow the rotating element to be removed without disconnecting the suction and discharge flanges.
- E. Impellers shall be of the enclosed type and shall be of vacuum cast bronze. Impellers shall be dynamically balanced, keyed to the shaft, and held in place with threaded shaft sleeves.
- F. The pump shaft shall be made of SAE 1045 Steel or equal, accurately machined to give a true running rotating element. Shaft shall be protected by bronze sleeves which are key locked and threaded so that the sleeves tighten with the rotation of the shaft. An o-ring shall seal between the impeller hub and the shaft sleeve to protect the pump shaft.
- G. Pump shall be equipped with renewable bronze casing rings so designed that hydraulic pressure will seat them against a shoulder in the pump case around the full periphery of the wearing ring. The wearing rings will be locked by dowelling to prevent rotation. The rotating element uses heavy duty grease lubricated ball bearings and shall be equipped with water slingers. Bearing housings shall be so designed to flush lubricant through the bearing. All pumps where the suction pressure is expected to average 40 P.S.I. or below, shall be provided with a lantern ring connected to the pressure side of

the pump by a cored passage in the parting flange of the pump. Stuffing boxes shall be equipped with split bronze packing glands designed for easy removal for packing inspection and maintenance.

2.3 FIRE PUMP ACCESSORIES

- A. The fire pump unit shall include the following accessories, as required by NFPA standards (depending on the conditions under which the pumps are to be installed).
1. OS&Y Gate valves with valve tamper switches (Butterfly valves with integral tamper switch may be used where permissible by code.)
 2. Fire pump full size bypass fitted with OS&Y valves with tamper switches or butterfly valves with tamper switches and check valve.
 3. Eccentric tapered suction reducer
 4. Concentric tapered discharge increaser
 5. Discharge tee
 6. Base elbow
 7. Hose valves
 8. Caps and chains
 9. Hose valve header
 10. Blind flange
 11. Suction and discharge pressure gauges, 4-1/2" dia. dial with snubber, valve cock and lever handle.
 12. Circulation relief valve
 13. Automatic air release valve
 14. Splash shield
 15. Balldrip valve
 16. Coupling guard

2.4 FIRE PUMP CONTROL EQUIPMENT FOR ELECTRIC DRIVE

- A. The Fire Pump motor control shall be U.L. (Underwriters Laboratories) Listed and/ or F.M. (Factory Mutual) Approved, where applicable. It shall be completely assembled, wired and tested by the control manufacturer before shipment from the factory, and shall be labeled "Fire Pump Controller." The controller shall be located as close as practical and within sight of the motor. The controller shall be so located or protected that it will not be injured by water escaping from the pump or connections. The controller shall be of the combined manual and automatic, soft start, and shall be complete with:
1. Disconnect switch - externally operable, quick-break type.
 2. Circuit breaker - time delay type with trips in all phases set for 300% of the motor full-load current. The interrupting capacity of circuit breaker shall be 10,000 asymmetrical amperes.
 3. Motor starter – Soft start type capable of being energized automatically through the pressure switch or manually by means of an externally operable handle.
 4. Pressure switch set to cut in at 118 p.s.i.g. and out at 128 p.s.i.g.
 5. Running period timer - set to keep motor in operation, when started automatically, for a minimum period of one minute for each 10 HP motor rating, but not to exceed 7 minutes.
 6. Pilot lamp - to indicate circuit breaker closed and power available.
 7. Ammeter test link and voltmeter test studs.

8. Alarm relay - to energize an audible or visible alarm through an independent source of power to indicate circuit breaker open or power failure.
9. Manual selection station - a two position station shall be provided on the enclosure marked "Automatic" and "Non-automatic."
10. Means shall be provided on the Controller to operate an alarm signal continuously while the pump is running. Control equipment shall meet all requirements of NFPA No.20.
11. The following alarm and trouble conditions shall be remotely annunciated/monitored through the facilities fire alarm system:
 - a. Fire pump running.
 - b. Phase reversal-loss of phase
 - c. Controller main switch turned to OFF or manual position.

2.5 JOCKEY PUMP WITH CONTROL PANEL

- A. The contractor shall furnish and install an Aurora PVM1-6 vertical multi-stage jockey pump to operate at 3450 rpm with a capacity of 5 gpm at a 70 psig boost to existing suction pressure. The pump shall be constructed with 304 stainless-steel impellers and diffusers, a high temperature mechanical seal with carbon versus silicon carbide, EPDM elastomers throughout, tungsten carbide vs. ceramic pump bushings, and a cast-iron motor bracket.
- B. Unit shall be coupled with a 3450 rpm motor of $\frac{3}{4}$ HP, 3 phase, 460 volt ODP enclosure using a rigid split coupling. Motor bearings shall be sized to allow a 20,000 minimum hour B10 calculated life.
- C. The jockey pump control panel shall be NEMA 2, wall-mounted, and contain a fused disconnect switch, control transformer, magnetic across-the-line starter, H-O-A selector switch, overload relays, and necessary circuitry to provide automatic start and stop from panel mounted pressure switch. Panel wired for 440-480 volts. Manufacturer to be identical to the main fire pump control panel manufacturer.

2.6 FIRE PUMP REMOTE ALARM PANEL

- A. The alarm panel shall be a factory assembled, wired and tested unit and shall conform to all the requirements of the latest edition of NFPA 20 National Electrical Code.
- B. The alarm panel shall be listed by UL, approved by Factory Mutual Research Corp. and certified by the Canadian Standards Association.
- C. The alarm panel shall be low voltage DC and make use of printed circuit boards which can be easily wired together for future additional alarms.
- D. The alarm panel shall have individual pilot lights to indicate its alarm condition which shall remain lighted until the alarm condition has been corrected. The alarm panel shall also have an audible alarm which shall sound when the alarm conditions occur and may be silenced by pressing a silence alarm button.
- E. Each alarm initiation shall be subsequent to any and all previous alarm conditions so that the silence button acknowledgment of any one alarm will not prevent the audible alarm sounding on successive alarm conditions.
- F. The alarm panel shall have a "Push-to-test" pushbutton for manually testing all pilot lights, audible alarms and output circuits. All alarm pilot lights and pushbuttons shall be plainly marked for identification.
- G. The alarm panel shall be NEMA Type 2 dripproof for indoor wall mounting.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Install all equipment, devices, etc., in strict accordance with manufacturer's instructions and code compliances.
- B. Provide access space around pumps for service. Provide no less than minimum as recommended by manufacturer.
- C. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. For base-mounted pumps, provide supports under elbows on pump suction and discharge.
- D. Provide drains for bases and seals, piped to and discharging to the floor drain.
- E. Provide vibration isolators for the installation.
- F. Provide a fire pump test header with the number of nozzles and valves as required for the fire pump.
- G. Lubricate pumps before start-up, if required by manufacturer.
- H. Qualified manufacturer's representative shall check, align and certify pumps prior to start-up.

3.2 FIELD QUALITY CONTROL/TESTS

- A. The pump and electric motor shall be thoroughly shop-tested by the respective manufacturers as required by NFPA Pamphlet No.20. The control panel shall also be tested as a unit. All such tests shall be conducted prior to shipment.
- B. The pump, driver, controller and all accessories shall be purchased under a unit contract. The pump shall be given a complete performance test with POSITIVE SUCTION PRESSURE. A certified performance curve shall be prepared and submitted. Pumps shall also be hydrostatically tested to twice the shut off pressure, but in no case less than 250 lbs. per sq. inch.
- C. The pump manufacturer shall assume unit responsibility and shall provide the services a factory trained representative to supervise and/or be available to conduct final field acceptance tests.
- D. Perform field acceptance testing under the provisions of NFPA 20.
- E. Hydrostatically test the entire system and piping in accordance with NFPA 20.
- F. Tests shall be witnessed by Delaware State Fire Marshal, Owner's Representative and the A/E Representative.

END OF SECTION

SECTION 21 01 72**CPVC SPRINKLER PIPING (Basis of Design)****PART 1 – GENERAL****1.1 PRODUCT DESCRIPTION**

CPVC fire sprinkler pipe and fittings shall be extruded/molded from BlazeMaster® CPVC compounds manufactured by Lubrizol Advanced Materials. The pipe compound shall meet cell class 23547 and the fittings compound shall meet cell class 24447 as defined by ASTM D1784. Both pipe and fittings compounds shall be certified by NSF International for use with potable water and shall be pressure rated by Plastics Pipe Institute (PPI).

1.2 PIPE AND FITTINGS

- A. Pipe shall meet or exceed the requirements of ASTM F442 material designation CPVC 4120-06 in standard dimension ratio (SDR) 13.5. Additionally, the pipe must be marked with the following pressure ratings: “320 PSI @ 73°F”, “175 PSI @150°F” and “100 PSI @ 180°F”.
- B. Fittings shall meet or exceed the requirements of ASTM F437 (schedule 80 threaded), ASTM F438 (schedule 40 socket) or ASTM F439 (Schedule 80 socket).
- C. Both pipe and fittings shall be Listed by Underwriters Laboratories for use in automatic fire sprinkler systems and shall bear the logo of the Listing Agency. See UL Fire Protection Equipment Directory, categories VIWT and HFYH.
- D. Both pipe and fittings shall be certified by NSF International for use with potable water.
- E. Ancillary products (including, but not limited to fire stops, thread sealants, leak detectors, etc.) coming into contact with pipe and fittings must be chemically compatible with BlazeMaster® CPVC pipe and fittings (reference the Lubrizol FBC™ System Compatible Program).

1.3 SOLVENT WELDING

- A. All socket type joints shall be assembled with solvent cements that meet or exceed the requirements of ASTM F493. Safe handling of solvent cements shall be in accordance with ASTM F402. Solvent cement shall be certified by NSF International for use with potable water, and approved by the manufacturers. The solvent cements shall be approved for use with BlazeMaster® CPVC pipe and fittings.
- B. BlazeMaster® CPVC pipe and fittings shall be listed by UL and also either ULC or C-UL for use in:
 - 1. Light Hazard occupancies as defined in NFPA 13, “Standard for the Installation of Sprinkler Systems.”
 - 2. Air plenums per the requirements of UL 1887, as defined by NFPA 90A, the International Mechanical Code, and the Uniform Mechanical Code.
 - 3. BlazeMaster® pipe and fittings shall be permitted to protect ordinary hazard rooms of otherwise light hazard occupancies where the room does not exceed 400 square feet (i.e. Laundry Room) as defined by NFPA13.

PART 2 – PRODUCTS**2.1 MATERIALS**

- A. CPVC fire sprinkler pipe and fittings for sizes 3” and smaller, shall be extruded/molded from BlazeMaster® CPVC compounds manufactured by Lubrizol Advanced Materials, or approved equal.

2.2 MANUFACTURERS

Georg Fischer Harvel, LLC **NIBCO, Inc.**
(PIPE) **(FITTINGS)**

300 Kuebler Rd Middlebury St
Easton, PA 18040 Elkhart, IN 46516
(610) 252-7355 (574) 295-3000

The Viking Corporation **IPEX, Inc.**
(PIPE) **(PIPE & FITTINGS)**
210 N Industrial Pkwy Dr 1425 North Service Road E, Unit 3
Hastings, MI 49058 Oakville, L6H 1A7
(269) 945-9501 (800) 463-9572

PART 3 – EXECUTION

3.1 SYSTEM DESIGN

- A. System design shall be in accordance with standard industry practices and standards for fire sprinkler systems and the manufacturer's design/installation instructions. The design shall take into consideration the pressure and flow requirements, friction loss, operating temperatures, support spacing, joining methods, and thermal expansion and contraction.
- B. The fire sprinkler piping system shall be hydraulically calculated using a Hazen-Williams C Factor of 150, and designed in accordance with the Standard for Installation of Sprinkler Systems (NFPA 13).
- C. The maximum design temperature/pressure rating shall not exceed 175 psi at 150°F.

3.2 INSTALLATION PROCEDURES

- A. Installation practices such as pipe support spacing, bracing, allowance for thermal expansion/contraction, solvent welding and handling and storage shall be in accordance with the manufacturer's instructions and the UL listing which includes installation limitations.
- B. Refer to 3.2 below for submittal of installer training documentation.

3.3 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Fire Sprinkler Contractor must submit to the Contracting Officer documentation that verifies personnel assigned to this project prior to beginning construction who have successfully completed formal CPVC fire sprinkler systems training conducted by an authorized BlazeMaster® fire sprinkler systems trainer. The Contractor Training documentation shall be specific to BlazeMaster® pipe and fittings. Personnel's training documentation must be current and have been updated within the past two (2) years. (NOTE: This training does not imply compliance with a local or state contractor certification or licensing laws.)

3.4 TECHNICAL DATA

- A. Applicable Standards
 - 1. NSF/ANSI Standard 14 Plastic Piping Components and Related Materials.
 - 2. NSF/ANSI Standard 61 Drinking Water System Components – Health Effects.
 - 3. ASTM D1784 Specification for Rigid Poly(Vinyl Chloride)(PVC) Compounds and Chlorinated Poly(Vinyl Chloride)(CPVC) Compounds

4. ASTM F402 Practice for Safe Handling of Solvent Cements, primers and Cleaners Used for Joining Thermoplastics Pipe and Fittings.
 5. ASTM F437 Specification for Threaded Chlorinated Poly(Vinyl Chloride) CPVC Plastic Pipe Fittings, Schedule 80.
 6. ASTM F438 Specification Socket-Type Chlorinated Poly(Vinyl Chloride) CPVC Plastic Pipe Fittings, Schedule 40.
 7. ASTM F439 Specification Socket-Type Chlorinated Poly(Vinyl Chloride) CPVC Plastic Pipe Fittings, Schedule 40.
 8. ASTM F442 Specification Chlorinated Poly(Vinyl Chloride) CPVC Plastic Pipe (SDR-PR).
 9. ASTM F493 Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) CPVC Plastic Pipe and Fittings.
 10. NFPA 13 Standard for the Installation of Sprinkler Systems.
 11. NFPA 24 Installation of Private Fire Service Mains and Their Appurtenances.
 12. NFPA 25 Standard for the Inspection, Testing and Maintenance of Water Based Extinguishing Systems.
 13. NFPA 90A Standard for the Installation of Air Conditioning and Ventilating Systems.
 14. UL 1887 Fire Test of Plastic Sprinkler Pipe for Flame and Smoke Characterization.
 15. UL 1821 Outline of Proposed Investigation for Thermoplastic Sprinkler Pipe and Fittings for Fire Protection Service.
 16. Piping compound has a 180°F Hydrostatic Design Basis (HBD) of 1250 psi as listed by the Plastic Pipe Institute.
 17. Fitting compound has a 180°F Hydrostatic Design Basis (HBD) of 1000 psi as listed by the Plastic Pipe Institute.
- B. Applicable Codes
1. ICC, International Building, Mechanical, and Plumbing Codes.
 2. IAMPO, Uniform Mechanical and Plumbing Codes.
 3. NBC, National Building Code of Canada.
- 3.4 TESTING
- A. After the system is installed and solvent-welded joints have cured per the manufacturer's installation instructions, the system shall be hydrostatically tested per the manufacturer's installation instructions and the requirements of the applicable NFPA Standard (NFPA 13) and per the local Codes/Rules/Regulations for the jurisdiction installed in.
 - B. Maintenance shall be in accordance with the Standard for Inspection, Testing, and Maintenance of Water Based Extinguishing Systems as defined by NFPA 25.
- 3.5 WARRANTY
- A. Consult the manufacturer for specific warranty information.

END OF SECTION

SECTION 22 00 00

GENERAL PROVISIONS - PLUMBING/FIRE PROTECTION

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary and other Conditions, if any) and all other applicable Divisions, apply to work of this Section.
- B. This specification or drawing and the design features or resulting construction disclosed, are the property of Furlow Associates, Inc., and shall not be reproduced without written permission.
- C. All fire protection suppression systems shall be part of and included in all of the following 220000 thru 220191 Sections.

1.2 WORK INCLUDED

- A. Provide labor, materials, equipment and supervision necessary to install complete operating Plumbing and Fire Protection Systems as indicated the drawings and specified herein, including all work at the site and within the proposed construction areas to accomplish the required work.

1.3 REGULATIONS, CODES AND STANDARDS

- A. Work shall be performed in accordance with latest adopted codes, regulations and ordinances by authorities having jurisdiction. Observe all safety regulations.
- B. Latest editions of any referenced standards shall govern.
- C. Obtain all municipal and/or the Authorities Having Jurisdiction permits and inspection certificates and pay all charges.
- D. Make or arrange for any/or all inspection agency reviews or visits and pay all charges. This includes communication with each respective agency and/or utility to verify the project system work, coordination responsibilities, fees, back charges, etc., required.
- E. All fees and back charges shall be verified during the bidding phase of the work. Any discrepancy of this item between any utility, inspection agency and the Contractor shall be brought to the attention of the A/E prior to bid opening.
- F. Submission of a bid will be deemed evidence of having complied with these requirements.

1.4 RELATED WORK

- A. Refer to equipment shown or specified in all other applicable Divisions that require Plumbing and Fire Protection services.
- B. Refer to work related to Plumbing and Fire Protection as shown on the following contract drawings:
Architectural & Structural
HVAC
Electrical

1.5 COORDINATION

- A. The Mechanical, Plumbing and Electrical Contractors are responsible to coordinate all manufacturer's recommended circuit breakers, starters, disconnects and fuse sizes for all equipment. Submission of a shop drawing will certify that this has been completed. Any necessary changes required will be included as part of this contract.
- B. Plumbing and Sprinkler Contractors shall coordinate scheduling, submittals and work of the various sections of the Project Manual to ensure efficient and orderly sequence of installation of independent work elements, with provisions to accommodate items that may be installed at a later time.

- C. Plumbing and Sprinkler Contractors shall verify utility requirements and all characteristics of operating equipment are compatible with the building utilities. Coordinate the work of all sections related and required for installing, connection and placing in service of all equipment.
- D. Plumbing and Sprinkler Contractors shall coordinate all space requirements, supports and installation of all mechanical, electrical, plumbing and fire protection work, which are indicated diagrammatically on the Drawings. Verify routing of all pipes, ducts, conduits and equipment connections. Maximize accessibility for other work, and service requirements for maintenance and repairs.
- E. Obtain written confirmation from all related trade Contractors and the Owner or his representative that requirements, conflicts and coordination issues have been discussed and resolved.

1.6 SUBMITTALS

A. Shop Drawings & Product Data:

- 1. Shop drawings and product data shall be submitted in accordance with Division 22 specifications except where herein modified.

NOTE: Submittals will only be reviewed once and resubmittals will be reviewed once. Any other submittals will be billed to the Contractor at the Engineer's standard rates.

- 2. Listed are the required shop drawings and reports required for this project. The Engineer/Owner shall reserve the right to require additional submissions not listed below:
 - All fixtures, equipment and associated devices so listed on the Fixture Schedule on Drawings.
 - Insulation
 - All specified piping systems.
 - All specified valves.
 - Gauges and thermometers
 - Recirculating pump.
 - Hanger and supports including Sumner system.
 - Piping labels and identification.
 - Sprinkler System and all related data, devices, switches and trimmings.
 - Sump pumps.
 - Testing reports.
 - Sterilization report.
 - Operating/Maintenance manuals.
 - As-Built Drawings.
- 3. Submittals comprising complete catalog cuts, shop drawings and performance test data for Plumbing and Fire Protection materials and equipment as required by other sections of Division 22, shall be submitted for review checking. The Contractor shall review these for conformance to contract documents prior to submission and affix contractor's signature to each submittal certifying that this review has been done. By approving and submitting shop drawings, product data, samples and similar materials, the Contractor represents that the Contractor has determined and verified materials, field measurements and field construction data that relates to the work, and has checked and coordinated this information with all of the requirements contained in the contract documents for the work of all trades.
 - a. The Contractor and equipment manufacturer shall clearly identify in all submittals and shop

drawings any and all applications standards which require additional work to accommodate this equipment and provide a complete and operational system as described in the contract documents.

- b. The Contractor shall be completely responsible for any and all additional costs associated with the changes required by this and all other trades.
 - c. The indicated sprinkler system components including zone valves, alarm and monitoring switches are the minimum requirement based on design and project requirements. If the bidding fire protection contractor elects to furnish and install a different arrangement to achieve the same end result and fire marshal approved system, this contractor shall be responsible for any and all added costs. This shall include but not be limited to the previous items mentioned as well as the additional support and monitoring requirements of the project fire alarm system. There shall be no additional cost to the owner or project.
4. All submittals shall have the following identification data, as applicable, contained therein or permanently adhered thereto.
- a. Project name.
 - b. Project number.
 - c. Sub-contractor's, vendor's and/or manufacturer's name and address.
 - d. Product identification.
 - e. Identification of deviation from contract documents.
 - f. Applicable contract drawings and specification section number.
 - g. Shop drawing title, drawing number, revision number, and date of drawing and revision.
 - h. Resubmit revised or additional submittals as requested.
 - i. Wherever shop drawings or vendor's standard data sheets indicate work to be done "by others", it shall be the responsibility of the contractor making the submission to identify by name, the contractor who is to do this work. If the contractor named is other than the contractor making the submission, the shop drawing submission must be reviewed by the named contractor and bear his mark of approval, prior to submission to the Architect/Engineer.
 - j. Where equipment proposed differs from that shown on the drawings or specified, he shall submit for approval drawings showing the manner in which the layout is affected by the substitution.
 - k. The Contractor shall keep one copy of approved shop drawings at the job site,, filed in a suitable metal container. The shop drawings shall be cataloged and kept in good repair, and shall be available for use by the Owner, Architect and Engineer.
 - l. No equipment shall be ordered, fabricated, etc., before approval of shop drawings.
- B. Contractor is responsible for the shop drawing coordination and interface with the work of other contracts and adjacent work. The relationship of Contractor's work shall be verified as it relates to adjacent and critical features of the work of this and all contracts and materials.
- 1.7 WARRANTY/GUARANTEE
- A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in all other applicable Divisions. In addition, refer to specifications for special guarantees.
 - B. Wherever in the specification sections of this division, reference is made to a specific warranty period, this warranty shall be in addition to and not a limitation of other rights the Owner may have against the Contractor under the contract documents.

1.8 SITE INSPECTION

- A. The Contractor shall visit the site, inspect, and become aware of all conditions which may affect the work during the estimation phase of his work and prior to bid openings. Investigate utilities, protection requirements for adjacent facilities, storage locations, and access to the construction area.
- B. Submission of a bid will be deemed evidence of having complied with this requirement.

1.9 SUBSTITUTIONS

- A. Whenever a material, article, piece of equipment or system is identified in the following specification or indicated on the drawings by reference to manufacturers' or vendors' names, trade names, catalog numbers or the like, it is so identified for the purpose of establishing the basis of the Bid.
- B. Substitution approval must be obtained and included as an addendum item prior to the submission of the bid. An approved substitution shall not be considered as an approval for the Contractor or an equipment vender to deviate from the written portion of the specifications unless so stated in the addendum.
- C. The drawings illustrate the space allocated for equipment and the Contractor shall install the equipment accordingly. If changes are required in the building or arrangement due to substitution of equipment, the Contractor making the substitution must pay for the necessary modifications.
- D. The listed equivalent or substituted manufacturers along with the bidding related contractor shall be completely responsible to comply with all requirements as indicated on all contract documents and as described within the specifications. This shall include, but shall not be limited to space requirements, code clearances, the type, horsepower, capacities, number and size of services required from other trades, including all required ancillary items furnished and installed by other trades. If the manufacturer or related bidding contractor does not comply with these requirements, then they shall be responsible for any and all additional costs associated with the changes required by other trades.

1.10 LUBRICATION

- A. Furnish, install and maintain all required lubrication of any equipment operated prior to acceptance by the Owner. Lubrication shall be as recommended by the equipment manufacturer.
- B. Provide one year's supply of lubricants to Owner at date of acceptance.
- C. Verify that required lubrication has taken place prior to any equipment start-up.

1.11 EQUIPMENT START-UP

- A. Verify proper installation by manufacturer or his representative.
- B. Advise General Contractor 2 days prior to actual start-up.
- C. Verify proper operation. Obtain signed statement by manufacturer or his representative that equipment is operating within warranty requirements. Submit statement to General Contractor.

1.12 OPERATION & MAINTENANCE INSTRUCTIONS

- A. Properly and fully instruct Owner's personnel in the operation and maintenance of all systems and equipment.
- B. Ensure that the Owner's personnel are familiar with all operations to carry on required activities.
- C. Such instruction shall be for each item of equipment and each system as a whole.
- D. Provide report that instruction has taken place. Include in the report the equipment and/or systems instructed, date, contractor, Owner's personnel, vendor, and that a complete operating and maintenance manual has been reviewed.
- E. Manual shall include all instructions on operation, maintenance, repair parts list, lubrication requirements, brochures, catalogue cuts, wiring diagrams, piping diagrams, control sequences,

service requirements, names and addresses of vendors, suppliers and emergency contacts. Three manuals shall be provided.

- F. Submit manuals for review prior to operating instruction period. Manuals shall be 8-1/2 x 11" with hard cover, suitably bound.
- G. Provide to the Owner any special tools necessary for operation and routine maintenance of any of the equipment.
- H. Furnish three (3) copies of a professionally taped video and three (3) copies of professionally prepared drawings demonstrating the following:
 - Location of main shut-off valves
 - Procedures for equipment start-up and seasonal shut-downs.
 - Procedures for maintenance.
 - Provide written version of all procedures included in video.

The above should cover all equipment/systems including, but not limited to the following:

- Sprinkler Systems
- Hot water heater and pumps
- Grease trap
- Flush valves
- Water coolers
- Sump pumps
- Mixing valve
- Solids interceptor

1.13 TOOLS

- A. All equipment furnished by the Contractor which requires special tools or devices other than those normally available to the maintenance or operating staff shall be furnished in duplicate to the Owner, sufficiently marked, packed or boxed for staff usage. The tools provided shall be listed by the Contractor identified as to their use or the equipment applicable in a written transmittal to the Owner.

1.14 CLEANING AND FINISHING

- A. After equipment start-up and all operating tests have been made and the system pronounced satisfactory, each respective Contractor shall go over the entire project, clean all equipment, etc., installed by him and leave in a clean and working condition. Any surfaces found marred after this final cleaning shall be refinished or replaced by each Contractor at no cost to the Owner.
- B. Provide for the safety and good condition of all materials and equipment until final acceptance by the Owner. Protect all materials and equipment from damage. Provide adequate and proper storage facilities during the progress of the work. Special care shall be taken to provide protection for bearings, open connections, pipe coils, pumps, compressors and similar equipment.
- C. All NEW fixtures, piping, finished surfaces and equipment installed shall have all grease, adhesive labels and foreign materials removed.
- D. All new piping installed shall be drained and flushed to remove grease and foreign matter. Pressure regulating assemblies, traps, flush valves and similar items shall be thoroughly cleaned. Remove and thoroughly clean and reinstall all liquid strainer screens after the system has been in operation ten (10) days.
- E. Gas piping shall be blown out with clean compressed air or inert gas.

- F. When connections are made to existing systems, the Contractor shall do all cleaning and purging of the existing systems required to restore them to the condition existing prior to the start of work.
- G. Clean-up: Remove from the premises, all unused material and debris resulting from the performance of work under this section.

PART 2 – PRODUCTS

2.1 GENERAL

- A. All material and equipment shall be new and of present-day manufacture, and shall conform to accepted standards of the trade where such a standard has been established for the particular type of equipment or material.
- B. Whenever equipment or material is referred to in the singular, such as "the plumbing fixture", it shall be deemed to apply to as many such items as necessary to complete the work.

2.2 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. During loading, transporting and unloading exercise care to prevent damage to material.
- B. Store all materials in dry enclosures or under protective coverings out of way of work progress.
- C. Material shall not be allowed to be stored directly on ground.
- D. Deliver in manufacturer's original cartons or on skids.
- E. Handle and protect so as to prevent damage to product or any surrounding material.

2.3 CONCRETE

- A. Concrete if used on this project, shall be in accordance with Section 033000.
- B. The 28-day minimum compressive strength shall be 3000 psi.

PART 3 – EXECUTION

3.1 PROTECTION

- A. Plug or cap open ends of piping systems.
- B. Stored materials shall be covered to prevent damage by inclement weather, sun, dust or moisture.
- C. Protect all installed work until accepted in place by the Owner.
- D. Plates, polished metal escutcheons and other finished devices shall not be installed until masonry, tile, and painting operations are complete unless otherwise protected.
- E. Protect all work from operations which may cause damage such as hauling, welding, soldering, painting, insulating and covering.
- F. Do not remove protective material until equipment is placed in service.

3.2 WORKMANSHIP

- A. Install all work neat, trim and plumb with building lines.
- B. Install work in spaces allocated.
- C. Cutting and patching shall be performed by skilled tradesmen normally employed for the work involved.

3.3 EXCAVATION

- A. The excavation shall be of the open-trench method and to the depths and widths as may be necessary. The Contractor shall do all excavation required in connection with his work. Bottoms of trenches shall be excavated to a uniform grade. All materials excavated shall be deposited on the side of the trenches and beyond the reach of the slides. Excavated material shall not be piled where it will interfere with traffic. If rock is encountered, it shall be removed by the General Contractor. See provisions in Division 2.

- B. Daily backfill of excavation shall be required on this site, no trenches shall be left open past the end of the work shift.
- C. No piping shall be bedded directly on rock. They shall be cushioned by a 6-inch layer of crushed stone or gravel of selected grade, of size to pass through 3/4" mesh sieve. Not less than 30% shall be fine which will pass through a 3/8" mesh sieve.

3.4 SHORING AND PUMPING

- A. The Contractor shall provide all shoring, bracing or sheet piling necessary to maintain the banks of his excavation and shall take out same as the work progresses and filling in has been accomplished. Shoring shall be in accordance with OSHA Standards.
- B. The arrangement of shoring must be such as to prevent any movement of the trench banks and consequent strains on the conduits. Shoring shall be provided to prevent damage to work installed by other trades.
- C. The Contractor shall do all pumping required to keep his excavations free of water. The water shall be conveyed in piping or watertight troughs a sufficient distance that it will flow from the site and not affect other work being performed.

3.5 BACKFILLING

- A. After work in trenches has been completed, they shall be filled with select fill in 8" layers and shall be pneumatically tamped before the next layer of material has been filled in. The backfill shall be free of excavated rock, cinders, stones, brickbats or other debris.
- B. Wherever rock is removed, the Contractor shall secure and fill select clean earth to a minimum depth of 3'-0" above the top of the pipe. Unless otherwise indicated, no rock shall be deposited in the trench fill. This clean earth fill shall be procured other than from the site unless permission for earth borrow from the site is granted by the Architect. If site borrow is permitted, the topsoil removal, relocation and finished grading will be accomplished as directed by the Architect.
- C. Under no circumstances shall excavated material be left where it will interfere with the Owner's or other Contractor's operations.
- D. All earth and other materials taken from the trenches and not required for backfilling shall be deposited where directed, or removed from the premises as directed by the Architect.
- E. Any rock removed from the excavation shall be removed from the project site by the Contractor.
- F. Trenches which pass under wall footings or within 18" of column footings shall be backfilled with lean concrete. To secure adequate foundation support, the method and depositing of the concrete fill shall be as directed by the Architect. To prevent the concrete from adhering to the pipes, necessary pipe protection shall be applied.

3.6 EQUIPMENT SETTING

- A. Furnish and install as a minimum, a 4-inch concrete pad beneath all floor-mounted equipment. Install anchor bolts in pour.
- B. Furnish and install as a minimum, spring vibration isolation under any equipment 10 HP and over and rubber in shear vibration isolation on any equipment up to 10 HP.
- C. Concrete shall be 3,000 psi, 28-day compressive strength in accordance with ACI-613. Reinforce with No. 4 rod 12" on centers both ways or as otherwise detailed.

3.7 FASTENERS, HANGERS AND SUPPORTS

- A. Furnish and install all hangers and supports required to suspend, mount, or hang the work.
- B. Furnish and install all miscellaneous steel angles, channels, beams, clips, brackets and anchors necessary to hang or support the work. Provide submissions for review.

- C. Install concrete inserts before concrete is poured.
- D. Drilled inserts shall not be loaded more than 1/4 rated capacity or 200 pounds.
- E. Power-driven fasteners shall not be allowed for piping larger than 2 inch, or equipment. When used they shall not be loaded more than 1/8 rated capacity or 200 pounds.
- F. All hangers, miscellaneous steel, braces and supports shall be galvanized, cadmium plated, or primed steel. Copper tubing shall be supported with copper hangers. No direct contact of dissimilar metals between the piping system and its hanger support shall be permitted.
- G. Piping shall be supported from adjustable clevis type hangers with insulation pipe saddles. Where hangers are 18" or longer, provide lateral bracing at every fourth hanger. See IPC Pipe Support Table below:

PIPE SUPPORT SPACING

Material	Horizontal Max. Feet	Vertical Max. Feet
ABS Pipe	4	10
Aluminum	10	15
Brass	10	10
Brass Tube up to 1-1/4"	6	10
Brass Tube over 1-1/2"	10	10
Cast Iron	5	15
Copper up to 1-1/4"	6	10
Copper over 1-1/4"	10	10
CPVC Up to 1"	3	10
CPVC Over 1"	4	10
Lead Pipe	Continuous	4
PB Pipe/Tubing	2.6 ft. (32")	10
PVC Pipe	4	10
PEX	2.6 ft. (32")	10
Steel Tubing	8	10
Steel Pipe	12	15

- H. Support vertical piping at floor levels using approved riser clamps. Clamp material shall be compatible with pipe material. Maximum vertical spacing shall be 10'-0".

3.8 SLEEVES

- A. Provide each pipe passing through a masonry or concrete wall, floor or partition with a sleeve made from standard weight steel pipe for pipe with smooth edges, securely and neatly cemented in place. Provide each pipe passing through a frame or metal partition with a sleeve made from No. 22 gauge galvanized sheet metal, securely fastened in place.
- B. Pipe passing through foundation wall or under foundation shall be provided with relieving arch or steel pipe per IPC Section 305.5.
- C. Be responsible for the proper location and alignment of all sleeves.

- D. Provide hydrostatic seals for sleeves passing through outside walls, below grade, or through hydrostatically sealed slabs or floors on grade. Provide fire-rated seals for all other sleeves.
 - E. Install both piping and sleeve seals so as to maintain integrity of seals with expansion and contraction of piping.
 - F. Set floor sleeves flush with floor surface in finished areas, 1" above the finished floor in kitchens, cafeterias, and similar service areas unless such areas are slab-on-grade; 1" above the floor in mechanical rooms, pipe chases, pipe spaces and other unfinished areas, unless otherwise indicated, and flush with the underside of slabs. Extend wall and partition sleeves through and cut flush with each surface unless otherwise indicated or specified.
 - G. Select sleeves two pipe sizes larger than any pipe that is to remain uncovered, unless otherwise required by the sealing method specified. Where pipes are to be covered, provide sleeves large enough to allow the covering to pass through the sleeves with sufficient clearance for sealing as specified hereinafter. Size sleeves for branch piping from vertical risers large enough to permit vertical expansion at the riser.
 - H. Place sleeves imbedded in concrete floors or walls in the forms before concrete is poured; sleeves shall have integral waterstop flanges, where they are to receive either watertight or hydrostatic seals.
 - I. Install sleeves passing through above-grade floors of mechanical rooms, toilet rooms, kitchens or similar service areas where liquid leaks or spillover may occur in a watertight manner. Sleeves shall be such that waterproofing membrane can be flashed around and into the sleeve where necessary.
 - J. Seal sleeves for pipes passing through ceiling air plenum walls or the floor above air tight in a manner similar to that specified for fire-rated sleeves.
 - K. Hydrostatic Sealing Method: Provide compressible synthetic rubber seals, equivalent to LINK SEAL, manufactured by the Thunderline Corporation, or THRUWALL manufactured by O.Z. Gedney. Install seals in accordance with the manufacturer's recommendations to provide air tightness aboveground and hydrostatic sealing belowgrade. Caulking or other type mastic is not acceptable.
 - L. Fire-Rated Sealing Method:
 - 1. Sleeves, openings and sealants shall comply with applicable codes, recommended practices and standards, and manufacturer's instructions. Fire sealants shall have ability to prevent spread of flame, smoke or water throughout the penetration and shall pass 3 hour test, UL test ASTM E814 and UL 1479.
 - 2. Products: Chase Corporation CTC PR-855, O. Z. Gedney CRS/CAFS, 3M Electro-Products Division Putty 303 or Caulk CP25 penetration sealing kits, General Electric Company sealants type RTV-850, 6428 or 7403, Thunderline Corporation "Link-Seal Pyro-Pak". Installation and type of sealant to be used as recommended by the manufacturer.
 - 3. Expansion collars, fire seal/firestop collars – ASTM E814 (UL1479). Spec Seal Corporation, Inc. (plastic pipe).
- 3.9 PLATES
- A. Furnish and install chrome plated plates wherever piping passes into finished area.
 - B. Plates shall be securely fastened to piping or building construction.
 - C. Floor plates shall cover 1-inch sleeve extension.
- 3.10 OFFSETS, TRANSITIONS, MODIFICATIONS
- A. Furnish and install all offsets necessary to install the work and to provide clearance for other trades.
 - B. Maintain adequate headroom and clearance.

- C. Incidental modifications necessary to the installation of the systems shall be made as necessary and as approved by the Architect.

3.11 RECESSES

- A. Furnish information to the General Contractor as to sizes and locations of recesses required to install panels, boxes, and other equipment or devices which are to be recessed in walls.
- B. Make offsets or modifications as required to suit final locations.

3.12 LABELING

- A. All Plumbing equipment such as pumps, and devices requiring identification for operating procedures shall be provided with permanent black laminated micarta white core labels with 3/8 inch letters.
- B. This shall also apply to all controllers, remote start/stop pushbuttons and equipment cabinets.

3.13 FLASHING AND COUNTERFLASHING

- A. Roof drains, vents, roof curbs, etc., shall have counterflashing fittings. General Contractor shall provide flashing.
- B. Piping and conduit thru the roof shall be flashed by the General Contractor. Furnish and install counterflashing.

3.14 ACCESS

- A. Locate all equipment, valves, devices and controllers which may need service in accessible places.
- B. Where access is not available, access panels shall be provided. Furnish access doors to the General Contractor for installation.
- C. Access doors shall be Elmdor, Karp Co., MIFAB or Controlled Air Manufacturing Limited, with 16 gauge frames and 14 gauge steel door, prime painted.
- D. Maintain required access clearances.

3.15 WIRING

- A. Packaged plumbing system equipment shall be furnished with disconnect switches, and magnetic starters, factory furnished and wired by the unit manufacturer.
- B. All control wiring shall be furnished and installed under this Division of the work.
- C. All wiring shall be in accordance with the National Electrical Code and as recommended by the equipment manufacturer.

3.16 UTILITIES

- A. Do not interrupt any utility or service to the Owner without adequate previous notice and schedule.
- B. Arrange and pay for the relocation, disconnection or removal of, or relocate, disconnect or remove existing utilities and services where such work is shown or where such utilities or services interfere with new construction, whether or not shown. Provide all excavation, backfilling and paving required by such work.
- C. Perform alteration of utilities and services in accordance with the rules, regulations and requirements of the involved utility companies, regulatory agencies having jurisdiction.

3.17 CUTTING AND PATCHING EXTERIOR SURFACES

- A. This Contractor shall be responsible for returning disturbed paved and/or grass areas to original condition where excavation for utilities has been required.
- B. Cut and patch paved areas to match original surface.
- C. Properly tamp backfill before finishing or repairing disturbed area surfaces.

3.18 OPENINGS - CUTTING, REPAIRING

- A. This contractor shall cooperate with the work to be done under other sections in providing information as to openings required in walls, slabs and footings for all piping and equipment, including sleeves where required.
- B. Any drilling or cutting required for the performance of work under this Section, shall be the responsibility of this Contractor and the cost thereof shall be borne by him.
- C. Holes in Concrete: Sleeves shall be furnished, accurately located and installed in forms before pouring of concrete. This contractor shall pay all additional costs for cutting of holes as the result of the incorrect location of sleeves. All holes through existing concrete shall be either core drill or saw cut. All holes required shall have the approval of the Structural Engineer prior to cutting or drilling.
- D. It shall be the responsibility of this Contractor to ascertain that all chases and openings are properly located.

3.19 GUARANTEE

- A. All materials and equipment provided and/or installed under this section of the specifications shall be guaranteed for a period of two years from the date of acceptance of the work by the Owner unless otherwise specified in other applicable Divisions. Should any trouble develop during this period due to defective materials or faulty workmanship, the Contractor shall furnish all necessary labor and materials to correct the trouble without any cost to the Owner. Any defective materials or inferior workmanship noticed at time of installation and/or during the guarantee period shall be corrected immediately to the entire satisfaction of the Owner.

In the event of occupancy by the Owner prior to final acceptance of the project, the guarantee date for equipment placed in operation shall be mutually agreed to by the Contractor and the Owner's representative.

3.20 DRAWINGS

- A. The Plumbing and Fire Protection Systems are indicated on the Contract Drawings. Certain pertinent information and details required by the Plumbing and Fire Protection Work appear on the Architectural, Structural and Electrical Drawings; become familiar with all Drawings; and incorporate all pertinent requirements.
- B. Drawings are diagrammatic and indicate the general arrangement of systems and requirements of the Work. Do not scale Drawings. Exact locations of fixtures and equipment, not specifically shown shall be obtained before starting work.
- C. When indicated on the drawings, plumbing riser diagrams are completely diagrammatic and indicate the intent of the work for both the Contractor, L&I review agencies and/or Authorities Having Jurisdiction. Where valves, shock absorbers, incidental equipment, devices, etc., including execution notes are indicated on the riser diagrams, they shall be so required and installed as part of the system work.

3.21 RECORD DRAWINGS

- A. As-Built record drawings, showing dimensions, locations and depth of all buried and concealed piping, plugged outlets and equipment shall be kept up to date. Master copy shall be kept on the job. No backfilling of trenches shall be permitted until as-built drawings are approved as up-to-date by the Owner/Representative. No plumbing progress payments shall be approved unless as-built drawings are up- to-date. Depth of sewers shall be from a permanent bench mark as shown on the contract drawings. Refer to project record drawings under General Conditions.

END OF SECTION

SECTION 22 00 10

BASIC MATERIALS AND METHODS - PLUMBING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the work specified in this Section.

1.2 REFERENCE

- A. Install all piping, fixtures, equipment, etc., to meet the requirements of the following:
 Middletown Department of License and Inspection
 Middletown Department of Sewers
 State of Delaware Plumbing Code
 Delaware State Fire Marshal's Office
 International Plumbing Code (All applicable sections)
 International Mechanical Code (All applicable sections)
 International Fuel Gas Code (All applicable sections)
 Gas Utility Company
 Water Company
 NFPA
 OSHA

All requirements of the above governing agencies shall be in compliance with the latest issues, rules or regulations in effect.

- B. Appliances and materials governed by UL requirements shall meet such requirements and bear the label.

1.3 QUALITY ASSURANCE

- A. Provide adequate supervision of labor force to assure all aspects of specifications are being fulfilled.
- B. Insure that all work and equipment is installed in accordance with manufacturer's warranty requirements.
- C. Replace all pipes and fittings shown to be defective as a result of testing.

1.4 SUBMITTALS

- A. Submit shop drawings and product data in accordance with Section 220000.
- B. Submit the following:
 - 1. Manufacturer's Product Data on all pipe and fittings to be used in project.
 - 2. Manufacturer's Product Data on all valves to be used in project.

1.5 WARRANTY/GUARANTEE

- A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, GENERAL REQUIREMENTS.

PART 2 – PRODUCTS

2.2 CAST IRON PIPE AND FITTINGS

(Note: Any cast iron piping made or marked "CHINA" will NOT be acceptable on this project)

A. Aboveground:

1. Pipe & Fittings: Hubless cast iron, CISPI 301, ASTM A-74 and ASTM A-888 shall be marked with the collective trademark of the Cast Iron Institute (soil pipe).
2. Joints: Neoprene sleeve and stainless steel shield and clamp assembly, CISPI 310, ASTM C-1277.

B. Below grade and/or slab: (Contractor's Option)

1. Bell and Spigot: Service weight bell and spigot pattern ASTM-74 with compression type neoprene gaskets ASTM C-564.
2. Hubless: Hubless cast iron pipe CISPI 301, with heavy duty 3.04.016 stainless steel bands for below-grade installation. Elastomeric seal component ASTM C-564 and CSA B-602.
3. Hubless Joints: Cast iron CISPI 310 and as TM C-1277.
4. PVC DWV pipe and fittings, Schedule 40, ASTM D-2665, D2949, F891 and CSA B181.2.
5. Corrosion protection shall be in accordance with IPC 305.1. Provide appropriate wrapping or sheathing when pipe is exposed to lime and acid of concrete, cinder or other corrosive materials.
6. Protection of all below-grade storm and sanitary shall be in accordance with IPC Section 305.
7. All Kitchen and Boiler Room below slab piping shall be service weight cast iron only. PVC not allowed.

C. Corrosion protection shall be in accordance with IPC 305.1. Provide appropriate wrapping or sheathing when piping is exposed to lime and acid of concrete, cinder or other corrosive materials.

2.3 COPPER TUBING

A. Domestic hot, cold and recirculated water:

1. Aboveground:

- a. Tubing: Hard-drawn, seamless ASTM B-88, Type "L".
- b. Fittings: Solder joint wrought copper ANSI B-16.22.
- c. Joints: Lead-free solder 410°, ASTM B-32 alloy designation "TC", ASTM B-828.
- d. Flux: Non-toxic and non-corrosive, ASTM B-813.

2. Underground:

- a. Tubing: Soft-drawn, seamless ASTM B-88, Type "K".
- b. Fittings: Solder joint wrought copper ANSI B-16.22.

- c. Joints: Lead-free solder 410°, ASTM B-32, ASTM B-828.
 - d. Flux: Non-toxic and non-corrosive, ASTM B-813.
 - B. Drainage and vent piping:
 - 1. Aboveground:
 - a. Tubing: Hard-drawn seamless ASTM B-88, ASTM B-75, Type "M" and DWV as pipe size permits.
 - b. Fittings: Solder joint cast copper drainage type ANSI B-16.29.
 - c. Joints: Soldered, 95/5 tin-antimony ASTM B-828, ASTM B-32.
 - d. Flux: Non-toxic and non-corrosive, ASTM B-813.
 - C. Solder/Flux: See Paragraph 3.4 of this section for Soldering/Brazing.
- 2.4 DUCTILE IRON PIPE
- A. Pipe: Ductile iron, ANSI A-21.51, ANSI/AWWA C151.
 - B. Joints: Rubber gasket, ANSI A-21.11, ANSI/AWWA C111.
 - C. Fittings: Mechanical joint, ANSI/AWWA C110, C153 bolt tolerances – AWWA C-111, ASTM A-563.
 - D. Lining: Cement mortar, ANSI A-21.4, ANSI/AWWA C104.
- 2.5 PVC GRAVITY SEWER PIPE
- A. Pipe: Unplasticized polyvinyl chloride (PVC) with integral wall bell and spigot joints.
 - B. Material: ASTM D-3034 for SDR 35, colored green for inground identification as sewer pipe.
 - C. Joints: Two sections of pipe shall be assembled in accordance with manufacturer's recommendations and tested as per ASTM D 3212 for use with flexible elastomeric seals.
 - D. Sizes: For site drainage systems 4" to 15".
 - E. Additional compliances:
 - 1. Drop Impact Test - ASTM D-2444
 - 2. Pipe Stiffness - ASTM D-2412
 - 3. Temperature for Testing - Designed to pass all tests at 73 degrees F (+/- 3 degrees F).
- 2.6 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS
- A. Aboveground – Drainage & Vent (Sanitary) IPC Table 202.1

1. ASTM D 2665
 2. ASTM D 2949
 3. CSA CAN/CSA B 181.2
 4. ASTM F 1488
 5. ASTM F-81
- B. Underground – Drainage & Vent (Sanitary) IPC Table 702.2
1. ASTM D 2665
 2. ASTM D 2949
 3. ASTM F 891
 4. CSA CAN/CSA-B 181.2
- C. Building Sewer Pipe (Near Water Service) IPC Table 702.3 (DWV)
1. ASTM D 2665
 2. ASTM D 2949
 3. ASTM D 3034
 4. ASTM F 891
 5. CSA B182.2
 6. CSA B 182.4 (Ribbed Sewer Pipe & Fittings)
- D. Fittings:
1. ASTM D 3311
 2. ASTM D-2665
 3. ASTM F-1866
- E. Solvent Cement: (All Purpose on ABS, PVC and CPVC)
- Potable Water, Sewer, Drain Waste and Vent
1. ASTM D-2564, D-2235 and F-493
 2. CSA B137.3
 3. CSA B181.2 or B182.1 (Sanitary Pipe only)

4. ASTM D2855
 5. CSA B181.1
- F. Primers: (PVC and CPVC)
1. ASTM F 656, purple color, SCAQMD Rule 1168 and OTC Regulations for VOC emission levels. NSF Standard 61 PW, DWV, Sewer.
- G. Uniformity: To insure installation uniformity, all piping components shall be of one manufacturer.
- 2.7 POLYPROPYLENE PIPE & FITTINGS
- A. Pipe & Fittings: Polypropylene flame-retardant ASTM D-2146 Schedule (40) (80).
 - B. Joints: (Aboveground)
 1. Mechanical
 2. Fusion welded socket ends.
 - C. Joints: (Below ground) Fusion welded - socket ends
- 2.8 CORRUGATED METAL PIPE
- A. Pipe:
 1. 24" diameter and smaller shall be 16 U.S. gauge steel.
 2. 30" diameter and larger shall be 14 U.S. gauge steel.
 3. All piping shall be completely bituminous coated on the interior and exterior and shall have a paved invert for 25% of its periphery.
 - B. Joints: Standard coupling bands and bolts as furnished by the pipe manufacturer.
- 2.9 VALVES (Copper Systems) – Solder ends of Threaded
- A. Valves listed below shall be for domestic water systems and comply with the latest requirements of NSF 61-8. Refer to individual sections for gas valves.
 - B. Ball Valves: NIBCO two-piece, full port, 600 psi WOG rated, cold non-shock valve with reinforced TFE seals, 316 stainless steel ball, Eco-brass body, ASTM 584, Alloy C87850, solder ends, or threaded non-blowout stem design. Acceptable NIBCO figure numbers: T/S 685-80-66-LF; T/S 595-Y-66-LF (3 piece).
 - C. Check Valves: NIBCO Class 125, Eco-brass body, ASTM 584, Alloy C87850, swing type, Y Pattern, threaded cap access. Acceptable NIBCO figure number: T/S 413-LF. For condensate drainage systems use the NIBCO T/S-413-B or approved equal. (NIBCO figure number T/S-413-B for condensate drainage.)
 - D. Gate Valves: NIBCO Class 125, Eco-Brass body, ASTM 584, Alloy C87850, Rising Stem. Acceptable NIBCO figure number: T/S 113-LF.
 - E. Balance Valves: All balance valves shall be provided with a memory stop feature with calibrated name plate to assure specific valve setting. Bronze body/brass ball, carbon filled TFE seat rings. NIBCO, Bell & Gosset, Accu-Flow, Taco or Flow Design "Accusetter". Acceptable NIBCO figure numbers: T/S 1710, F/G 737.
 - F. Strainers:
 1. Class 125 Bronze Y-Strainer, body to be ASTM B584 or B62 bronze with threaded, solder or female press end connections and .033-inch perforated type 304 stainless steel screen or 20 mesh

- type 304 stainless steel screen accessible without removing the strainer from the line. Acceptable Figure numbers: NIBCO Fig. S/T-221, S/T-222, PF-221/222-A, B.
2. Class 125 Flanged Cast Iron Y-Strainer, body to be ASTM A-126 Class B cast iron. End connections to be Class 125 flanged, tapped bolted bonnet with plug. Screen shall be .033-inch perforated type 304 stainless steel screen or 20 mesh type 304 stainless steel screen accessible without removing the strainer from the line. Acceptable Figure numbers: NIBCO Fig. F 721-A.
 3. Class 250 Threaded Cast Iron Y-Strainer: Strainer body to be ASTM A-126 Class B cast iron. End connections to be Class 250 threaded, tapped screw-in bonnet with plug. Screen shall be .033-inch perforated type 304 stainless steel screen or 20 mesh type 304 stainless steel screen accessible without removing the strainer from the line. Acceptable Figure numbers: NIBCO Fig. T-751-A
- G. VALVES (Copper Systems) – Press Fit
1. Valves listed below shall be for domestic water systems and comply with the latest requirements of NSF-61-8.
 - a. 2 Inch and Smaller Ball Valves (On/Off):

Ball Valves with male or female press to connect shall be rated at 200 PSI CWP to +225°F maximum. Valves shall be manufactured in accordance with MSS SP-110 and constructed of dezincification resistant cast bronze bodies. Brass with more than 15% zinc shall not be approved. Valve shall have reinforced PTFE Seats, Blow-out Proof Stem, Full Port Ball, Chrome/Nickel Plated or Stainless-Steel Ball for aggressive water.
 - b. 2 Inch and Smaller Check Valves (Swing Type):

Check valves shall be swing type Y pattern with male or female press to connect ends and shall be rated 200 PSI CWP to + 250°F maximum. Valves shall be manufactured in accordance with MSS SP-80. Body & cap shall be manufactured of dezincification resistant cast bronze ASTM B62 or ASTM B584 Alloy C8440. Valves shall have PTFE seat disc.
 - c. 2 Inch and Smaller Check Valves (Lift or Spring Type):

Incline resilient disc, spring actuated, 250psi rating, non-shock cold working pressure, 2500F maximum working temperature, bronze ASTM B584 alloy C84400. Stainless steel stem and disc holder and spring, EDPM O-ring.
- H. Insofar as possible, all valves of the same type shall be of the same manufacturer.
- I. Valve Manufacturers: Subject to compliance with requirements, provide valves of one of the following:
- Apollo/Conbraco
Stockham
Nibco
Milwaukee
Watts
Hammond
Webstone
- J. System Application:
1. Domestic Water:
 - a. Check Valves - 2" & Smaller - threaded or soldered.
 - b. Ball Valves - 3" & Smaller - threaded or soldered.

- c. Balance Valves - All sizes - threaded.
- d. Butterfly Valves - 4" and larger - flanged.
- e. Butterfly Valves – 3" and smaller – wafer type.

2.10 THERMOMETERS

- A. Separable socket, inserted into fluid flow, adjustable, hermetically sealed, red mercury, die-cast, baked enamel finish, double strength glass lens, white scale and black graduations.
- B. Scale: Select range of thermometer to indicate normal operating temperature at mid-point of scale for domestic water systems.
- C. Manufacturer: U.S. Gauge, H.O. Trerice, Moeller, Duro.

2.11 GAUGES

- A. Phosphor bronze bourdon tube, polypropylene case, gasketed glass crystal, aluminum dial, black graduations 4-1/2 inch diameter.
- B. Range: 0 to 150 psi, 5 pound intervals, 1/2 pound graduations.
- C. Manufacturers: Danton, U.S. Gauge, H.O. Trerice, Moeller.
- D. Install with bronze gauge cock.

2.12 ISOLATING FITTINGS

- A. Furnish isolating fittings between all sections of dissimilar piping materials or piping, general supports, equipment and supports, including piping hanger and rack supports where one material is ferrous and the other is non-ferrous.
- B. Install copper or brass piping or tubing in such a way as not to touch or come in contact with ferrous metals.
- C. Where ferrous piping or equipment is connected to copper or brass piping, make connection with insulating or dielectric unions to prevent electrolytic action between the ferrous and non-ferrous metals.
- D. Where copper or brass piping, tubing or fittings are anchored to, supported by or may come in contact with ferrous metal construction, provide an insulating nonconductor spacer of rubber, fiber or equivalent material to assure prevention of electrolysis.
- E. Manufacturer: Epco Sales, Inc., or insulated unions by Central Plastic Co.

2.13 ANCHORS AND GUIDES

- A. Anchors and guides shall be provided to support and maintain pipes in position and properly distribute expansion. The anchors and guides must be securely fastened to the building structure, and must be completely installed before the system is tested.
- B. Guides shall be as manufactured by J.J. McNally, Inc., Flexonics, Inc., Tube-Turns, American District Steam Co.

2.14 UNIONS

- A. Up to and including 2-inch pipe size: Screwed pattern, bronze-to-bronze seat.
- B. Above 2-inch pipe size: 125 Class Flanged pattern, A.S.A. sweat copper fitting, with gaskets, bolts and nuts.
- C. Copper tubing unions shall have sweated type ends. Flanged unions on copper tubing may be soldered connections.
- D. Materials and pressure ratings shall be the same as specified for the respective pipe and fitting system unless otherwise specified.

2.15 Polypropylene Randan Co. Polymer (PP-R) pipe and fittings for domestic water piping. See

Specifications Section 22 01 21 (PP-R) Domestic Water Piping (Basis of Design).

- 2.16 CPVC Automatic Sprinkler Piping and fillings for sprinkler piping 3" and smaller. See specifications section 21 01 72 CPVC Sprinkler Piping (Basis of Design).

PART 3 – EXECUTION

3.1 PIPING SYSTEM INSTALLATION REQUIREMENTS

- A. Drawings are generally diagrammatic and due to small scale, it is impossible to indicate all fittings, valves, gauges and specialties required. Provide complete operating systems and all necessary fittings, valves gauges and specialties whether or not indicated.
- B. Install all piping in accordance with the best practices of the trade and latest code requirements. Use uniform system materials throughout the building. All branch take-offs shall be off the top of the pipe.
- C. Pipe and fittings shall be clean from cutting burrs, foreign materials and defects in structure and threading. Make all cuts square. Ream after cutting. Clean off scale and dirt inside and outside, before assembly. Remove welding slag or other foreign material.
- D. Keep all piping as high as possible, consistent with proper pitch, to maintain maximum headroom. Cut piping accurately to measurements established at the building, work into place without springing, forcing or cutting of the building structure, and install as directly as possible between connecting points parallel with or at right angles to building construction, except as required to obtain pitch.
- E. Unless otherwise shown, run piping within the building, concealed in the walls, furred spaces, pipe spaces or above suspended ceilings. Unless otherwise noted, do not build in or bury horizontal piping in partitions. Install all exposed piping as closely as possible to walls, ceilings and columns, consistent with access and applicable insulation requirements.
- F. All piping to drain to low points. Low points will be provided with drain valves with hose thread. All piping shall have high points vented with ball valve, nipple and threaded cap.
- G. Do not install trapped lines where water cannot be drained or air can accumulate without being vented.
- H. Piping shall run square with building lines.
- I. Piping shall not be insulated or covered until tested and until building is closed in.
- J. Necessary drains, off-sets, vents and drips shall be provided for coordination of the work as part of the contract.
- K. Piping shall not be installed over electrical transformers, panels, switchgear, substations, and control panels as per the National Electric Code. No piping shall be installed in elevator machine rooms unless it is directly related to the room's system equipment.
- L. Allow clearance for expansion and contraction.
- M. Install isolating fittings between sections of ferrous and non-ferrous pipe or connected equipment.
- N. Valves shall be installed with stems above horizontal.
- O. Valves shall be installed on all sides of equipment and control valves to allow isolation for repair.
- P. Do not support piping from other piping, conduits or equipment. Provide additional bracing to prevent movement of trapeze piping, or any singular run of pipe to fixtures. Provide additional bracing on all piping through walls to flush valves to prevent movement during normal operation or performing maintenance on valves.
- Q. Thermometers and gauges shall be installed where indicated on the drawings, required by equipment specifications and where indicated elsewhere in the specifications. Gauges shall be located at an

elevation that can be readable.

- R. Unions shall be provided adjacent to all valves, at equipment connections, and where necessary to facilitate dismantling of the piping system.
- S. Ball valves to be installed with the proper clearance for operating the valve handle. A minimum clearance of 10" from center of valve to wall must be maintained for ease of operation.
- T. Thermometers are to be located so they can easily be seen from the floor in front of unit. Make final adjustment by tilting thermometer. Locate bulb in waterway with an oversized tee or elbow fitting.
- U. Install pressure gauges on incoming services both domestic water and fire services. Locate pressure gauge after main shut-off valve and ahead of water meter if one is provided within building.
- V. All pipe unions installed shall be accessible. Unions shall not be concealed or located in places where they cannot be maintained.
- W. Support and bracing of 4" and above pipe shall be in accordance with the CISPI Standards and IPC Chapter 3.
- X. All hangers, anchors, support and guides for piping, and equipment shall be securely fastened to the building structure and/or floors with concrete decking with the following exception. Hangers, anchors, support and guides shall not be fastened to or through metal roof decking (i.e. bare metal decking or metal deck supporting a roofing system).

3.2 TAGS, CHARTS, AND IDENTIFICATION

- A. All piping shall be labeled in accordance with IPC 303.1 and 303.4.
- B. Identify each valve in all systems with black, numbered and stamped 1-1/2" brass or aluminum tags fastened to valve by brass chain and S-hook.
- C. Piping Identification: Provide identification and safety products, semi-rigid plastic, wraparound pipe markers with flow arrows and conforming to ANSI A13.1. Locate marker at each valve, changes in direction, where pipes pass thru barriers and every 25' of horizontal runs. Lettering on background shall be in accordance with the following colors:

Legend	Background	Lettering
1. Gas	- Yellow	- Black
2. Fire Protection	- Red	- White
3. Domestic Cold Water	- Green	- White
4. Domestic Hot Water (110° ^ 140°)	- Yellow	- Black
5. Domestic Hot Water Return (110° ^ 140°)	- Yellow	- Black
6. Sanitary Drainage	- Green	- White
7. Condensate Drainage	- Yellow	- Black
8. Vent	- Yellow	- Black
9. Storm Drainage	- Green	- White
10. Medical Gas	Conform to NFPA-99 Regulations	
11. Plant Compressed Air	- Yellow	- Black

- D. Provide 1/8" scale diagrams showing location, number and service or function of each tagged item.
 - 1. Frame diagrams in approved metal frames with clear acrylic front, hinges, and locks.
 - 2. Secure to wall in Mechanical Room.
 - 3. Provide two additional separate copies permanently covered and bound.

- E. Furnish and install color coded 1" diameter markers on ceiling tile grids to indicate system and valve locations.
 - 1. Domestic cold water: - Green
 - 2. Domestic hot water: - Yellow
 - 3. Domestic hot water return: - Yellow
 - 4. Gas - Yellow
- F. Available Manufacturers: Subject to compliance with requirements, manufacturer's offering identification markers which may be incorporated in the work are limited to the following:
 - Seton
 - Brimar
 - B-Line
 - Marking Services, Inc.

3.3 WELDING

- A. All concealed and inaccessible black steel piping shall be welded.
- B. All black steel piping larger than 2 inch shall be fusion welded.
- C. All elevated pressure (above 14 in WC) natural or propane gas piping within buildings shall be welded joints.
- D. All elbows, tees and branch connections shall be made with welding fittings ANSI B16.9.
- E. Welding shall be in accordance with the ASME Boiler and Pressure Vessel Code Section IX.
- F. Furnish welder test certificate for review. Certificates of successful qualification by the following organizations shall be acceptable.
 - 1. ASME Boiler and Pressure Vessel Code
 - 2. ANSI Code for Pressure Piping
 - 3. National Certified Pipe Welding Bureau
 - 4. Military Specification MIL-STD-248

3.4 SOLDERING/BRAZING

- A. Connections between copper tubing and copper sweat fittings shall be made by soldering using Taramet Sterling or approved substitute. Flux shall be non-corrosive type "Nokorode" or approved substitute or as recommended by the manufacturer of the solder.
- B. All solder shall be "lead nickel and antimony free" in accordance with the Federal Safe Drinking Water Act Amendments of 1986 and 1996 as is ASTM B-32 Grade TC.

Composition:

Tin	95%
Copper	4.0 – 5.0%
Selenium	.04 - .2%
Tensile Strength	7,130 psi
Shear Strength	5,970 psi
Melting temperature	410°F

- C. Tubing shall be cut square and then reamed and deburred. End of tubing and inside of fitting cup shall be cleaned with steel wool and the flux shall be applied to the clean surface before soldering. After soldering, the excess solder shall be wiped off while still plastic.

- D. Silver brazing alloy shall be equal to and shall be used for joints in:
 - 1. Medical Gas Piping (All Systems)
 - 2. Medical Vacuum Piping
 - E. Brazed Joints:
 - 1. All brazed joints shall be cleaned. An approved flux shall be applied; joint filler metal shall conform to AWS A5.8.
 - 2. Flux shall meet AWS Standard A5.31, Type F83-A or F83-C.
 - F. 410 solder shall be used for all joints in:
 - 1. Domestic cold water
 - 2. Domestic hot water
 - 3. Domestic hot water return
 - 4. Copper drainage piping
 - 5. Plant compressed air
 - G. Lead-Tin (50-50) solder or any solder containing lead shall NOT be used or permitted for joint connections on this project.
 - H. Where the silver brazing is performed in a confined non-ventilated space, a non-toxic, cadmium-free brazing alloy such as Stay-Brite shall be used instead of Easy-Flo. Bring joint to solder temperature or brazing temperature in as short a time as possible.
 - I. Form continuous solder bead or brazing filler bead around entire circumference of joint.
 - J. Wipe excess solder from joint area while solder is still plastic.
 - K. Solder joints shall be in accordance with IPC Section 605.2, 605.14.3 and ASTM B838. Flux shall conform to ASTM B-813.
- 3.5 PRESS-FIT SYSTEM
- A. All new domestic water piping installed on this project shall be a solderless, press-fit, domestic water system. The system shall be Viega/Rigid copper press fitting system. Fittings shall be rated 0°F to 250°F at 200 psi and tested to 600 psi.
 - B. Fittings shall meet ANSI/NSF 61, – ASME B-16.22 and ASTM B88. Elastomeric seals shall meet ASTM D-2000.
 - C. Mechanical joining shall be recognized by:
 - IPC International Plumbing Code
 - SBCCI Standard Plumbing Code
 - IAPMO Uniform Plumbing Code
 - PHCC National Standard Plumbing Code
 - D. Copper and copper alloy press fittings shall conform to material requirements of ASME B16.18 or ASME B16.22 and performance criteria of IAPMO PS 117. Sealing elements for press fittings shall be EPDM. Sealing elements shall be factory installed or an alternative supplied by fitting manufacturer. Press end shall have SC (Smart Connect) feature design (leakage path). Smart Connect™ (SC Feature). In press-fit ½” to 4” dimensions, the Smart Connect Feature assures leakage of liquids and/or gases from inside the system past the sealing element of an unpressed connection. This feature shall provide the installer quick and easy identification of connections which have not been pressed prior to putting the system into operation.
 - E. Press Connections: Copper press fitting joints shall be made in accordance with the manufacturer's installation instructions. The tubing shall be fully inserted into the fitting and the tubing marked at

the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. The joints shall be pressed using the tool approved by the manufacturer.

- F. Installer shall be a qualified installer, licensed within the jurisdiction, and familiar with the installation of press-fit copper press joint systems. Press-fit copper press fittings shall be installed using the proper tool, actuator, jaws and rings as instructed by the press fitting manufacturer. The installation of copper tubing for hot and cold water distribution systems shall conform to the requirements of the ICC International Plumbing Code or IAPMO Uniform Plumbing Code.
- G. Note: Viega ProPress and Nibco press-fit installation shall only be permitted on this project. Push-on shark-teeth, or any type connection fittings that are not press-fit, shall NOT be approved.
- H. T-drill mechanically formed tee fittings shall be used in conjunction with the press-fit copper system in accordance with the IPC Chapter 6 Section 605.5.1, 605.5.1.2 and 605.14.1. Use caution around combustible material and follow all safety guidelines for open flame during silver brazing.

END OF SECTION

SECTION 22 00 30
INSULATION & COVERING – PLUMBING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the Work specified in this Section.

1.2 DESCRIPTION OF WORK

- A. This section includes insulation and covering furnished and installed on the following piping systems and equipment:
 - 1. Domestic cold water.
 - 2. Domestic hot water supply and return
 - 3. "Primary" Horizontal rainwater conductors including underside of roof drains. "Secondary" rainwater systems insulation is not required.
 - 4. Condensate waste piping from air conditioning units.
 - 5. Exposed waste, trap and wall supplies at all handicap lavatories.
 - 6. Branch waste lines from all chilled water fountains.

1.3 REFERENCE STANDARDS

- A. Refer to Section 220000 for a general description of requirements applying to this section.
- B. Materials shall conform to the requirements of the NFPA Code.

1.4 QUALITY ASSURANCE

- A. Refer to Section 220010 for a general description of requirements applying to this section.

1.5 SUBMITTALS

- A. Submit shop drawings and product data in accordance with Section 220000.
- B. Submit the following:
 - 1. Product data on all insulation and covering.

1.6 WARRANTY/GUARANTEE

- A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, GENERAL REQUIREMENTS.

PART 2 – PRODUCTS

2.1 PIPE INSULATION MATERIAL

- A. Fiberglass:
 - 1. Material: Preformed fiberglass bonded with resins to form circular pipe sleeves with factory applied, white all-service jacket bonded to reinforced foil vapor barrier jacketing. The jacket shall have factory-applied double pressure-sensitive adhesive closure and vapor sealing of longitudinal joints. Thermal Conductivity: .25 per inch at 100 degrees F. Flame spread of 25 and developed smoke of 50 or less.
 - 2. All Valves and Fittings:
 - a. Class fiber insert and premolded PVC cover, Manville "Zeston" and "Hi-Lo Temp Inserts" for valves and fittings.
 - b. Factory molded fibrous glass fitting covering for fittings.

- c. Mitered sections of pipe covering for valves.
- 3. Manufacturers: Johns-Manville, Certain-Teed, Owens-Corning.
- B. Closed Cell:
 - 1. Material: Flexible elastomeric foamed plastic closed cell structure insulation 25/50 rated with a flame spread rating of 25 or less and a smoke developed rating of 50 or less.
 - 2. Flexible pipe insulation shall be a foamed plastic closed cell structure material, with a thermal conductivity of not more than 0.27 Btu/Hr./Sq. Ft./Inch at a mean temperature of 75 degrees F. The insulation shall have an average density of at least 2 pounds per cubic foot, shall be self-extinguishing, and shall have a water vapor transmission rating of not more than 0.1 perms. Between temperature limits of -40 degrees F and plus 220 degrees F, the insulation shall not indicate any deviation from its original state.
 - 3. Manufacturers: Armacel, Insul-Tube, Nomaco Insulation.
 - 4. Specification Compliance: (Latest accepted Standards and Codes)
 - IECC 804.5: Insulation thickness for domestic hot and recirculation mains.
 - ASTM-E-84 Flame spread and smoke developed.
 - NFPA 255: Standard method of test of surface burning of building materials.
 - ASTM C177: Thermal conductivity.
 - NFPA 90A, 90B: Flame & smoke rating
 - ASTM-C-534 Type 1 Tubular Grade, Self-Sealing
 - UL 181 Factory made air ducts and air connectors. (Armacell UL181 has to do with mold growth)
 - UL723 Test for surface burning characteristics of building materials.
 - ASTM G21/C1338: Fungi resistance
 - ASTM G2: Bacterial Resistance
 - ASTM D1056, 2B1: Standard spec for flexible cellular materials.
 - MIL-P-15280J, FORMT
 - MIL-C-3133B (MIL STD 670B) Grade SBE-3
 - MEA 96-85M
- C. Covering of Pipe Insulation Outdoors:
 - 1. Wrapping: Wrap insulation with embossed .016" aluminum jacket.
 - 2. Fastenings: Cover shall be held in place with soft aluminum bands on 12" centers.
 - 3. Valves and Fittings: Weatherproof all valves and fittings.
 - 4. Manufacturers: Johns-Manville, Certain-Teed, Owens-Corning, Knauf.
- D. Protective cover for foam insulation in wet areas indoors:
 - 1. PVC heavy duty fitting covers and jacketing for kitchen wet areas.
 - 2. Fitting covers shall be glossy white, high impact, UV resistant PVC.
 - 3. Operating Temperature Limit: Up to 150°F.
 - 4. Flame Spread: 25 or less.
 - 5. Smoke Developed: 50 or less.
 - 6. Grade: Weatherable.

7. Color: White
8. Finish: Gloss
9. Fitting covers and jacketing shall be “Zeston” 300 Series PVC, heavy duty covers and “Zeston” PVC jacketing.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Do not install until systems have been tested and meet requirements.
- B. Do not install until building is closed in.
- C. Heavy work which may damage insulation shall have been completed in the vicinity of the insulation work.
- D. All installations shall be made by skilled craftsmen regularly engaged in this type of work.
- E. Insulation shall be continuous thru-wall, ceiling and floors.
- F. Pipe and equipment to be clean and dry prior to insulating.
- G. Install all insulation in strict conformance with manufacturer's instructions.
- H. Install pipe insulation by slitting tubular sections and applying onto piping or tubing. Alternately, whenever possible, slide unslit sections over the open ends of piping or tubing. All seams and butt joints shall be adhered and sealed using Armaflex 520 or 520 BLV Adhesive. If when using AP Armaflex SS, only the butt joints shall be adhered using Armaflex 520 or 520 BLV Adhesive, Armaflex HT 625 Adhesive shall be used with HT Armaflex.
- I. Insulation shall be pushed onto the pipe, never pulled. Stretching of insulation may result in open seams and joints.
- J. Tape the ends of the copper tubing before slipping the Armaflex insulation over the new pipes to prevent dust from entering the pipe.
- K. All edges shall be clean cut. Rough or jagged edges of the insulation shall not be permitted. Proper tools such as sharp, non-serrated knives must be used.
- L. On cold piping, insulation shall be adhered directly to the piping at the high end of the run using a two-inch strip of Armaflex 520 or 520 BLV Adhesive on the ID of the insulation and on the pipe. All exposed end cuts of the insulation shall be coated with Armaflex 520 or 520 BLV Adhesive. All penetrations through the insulation and termination points must be adhered to the substrate to prevent condensation migration.
- M. Sheet insulation shall be used on all pipes larger than 6” IPS. Insulation shall not be stretched around the pipe. On pipes larger than 12” IPS, adhere insulation directly to the pipe on the lower 1/3 of the pipe.
- N. Seams shall be staggered when applying multiple layers of insulation.

3.2 VALVES, FLANGES AND FITTINGS:

- A. All fittings shall be insulated with the same insulation thickness as the adjacent piping. All seams and mitered joints shall be adhered with Armaflex 520 or 520 BLV Adhesive. Screwed fittings shall be sleeved and adhered with a minimum 1” overlap onto the adjacent insulation. Armaflex HT 625 Adhesive shall be used with HT Armaflex.
- B. Valves, flanges, strainers and Victaulic couplings shall be insulated using Armaflex donuts that shall then be covered with sheet or oversized tubular insulation.

3.3 HANGERS

- A. Support piping system using high density inserts with sufficient compressive strength. The pipe

support insulation shall be elastomeric foam with the same or greater thickness than the pipe insulation. All joints shall be sealed with Armaflex 520 or 520 BLV adhesive.

- B. Standard and split hangers: Piping supported by ring hangers shall have hangers insulated with the same insulation thickness as the adjacent pipe. All seams and butt joints shall be sealed with Armaflex 520 or 520 BLV Adhesive. Armaflex HT 625 Adhesive shall be used with HT Armaflex. Ring hangers may be sleeved using oversized tubular insulation. On cold piping, insulation shall extend up the hanger rod a distance equal to four times the insulation thickness. Insulation tape may be used to a thickness equal to the adjacent insulation thickness.

- C. Clevis Hangers or other pipe support systems: Saddles shall be installed under all insulated lines at unistrut clamps, clevis hangers or locations where the insulation may be compressed due to the weight of the pipe. All piping shall have wooden dowels or blocks of a thickness equal to the insulation inserted and adhered to the insulation between the pipe and the saddle.

It is highly recommended for continuous insulation protection to use hanger sizes equal to the outer diameter of the pipe plus insulation thickness

- D. Armafix IPH or Armafix NPH can be used to prevent compression of insulation at standard split, clevis hangers or other pipe support systems. To minimize the movement of Armafix, it is recommended that a pair of non-skid pads be adhered to the clamps. In addition, to prevent loosening of the clamps, use of an antivibratory fastener, such as a nylon-locking nut, is also recommended.

3.4 PIPE COVERING (FOAMED PLASTIC TYPE)

- A. All joints and seams shall be sealed with a compatible adhesive. Approved adhesives are as follows:
 Armacel No. 520 (Low VOC use 520 BLV)
 Benjamin Foster Company No. 85-75 up to 200 degrees F.
 Contractor may use self-sealing insulation in lieu of above.
- B. Fitting covers shall be fabricated from the foamed plastic pipe insulation or from sheet insulation of the identical material. The fabrication shall be in accordance with manufacturer's instructions, and all seams mitered joints shall be joined using the adhesives described.

3.5 PIPE INSULATION – TYPES & THICKNESSES

- A. Flexible Closed Cell:

Piping System	Up to 3"	Over 3" to 6"	Over 6"
Cold Water	1/2"	1/2"	3/4"
Tempered Water (85° - 110°)	1"	1"	1-1/2"
Hot Water (140°)	1"	1"	1-1/2"
Hot Water Return (140°)	1"	1"	1-1/2"
Condensate Waste	1/2"	1/2"	-
Horizontal Storm (Primary)	1/2"	1/2"	3/4"
Horizontal Storm (Secondary)	-----Not Required-----		
Underside of Roof Drains	1/2"	1/2"	3/4"
Branch Waste From EWC's	1/2"	---	---
Handicap Lav Waste & Water	1/2"	---	---
Soil/Waste Piping Above Ceiling (where indicated)	1/2"	1/2"	3/4"

- B. Fiberglass:

Piping System	Up to 3"	Over 3" to 6"	Over 6"
Cold Water	1/2"	1/2"	3/4"
Hot Water	1"	1"	1-1/2"
Hot Water Return	1"	1"	1-1/2"
Tempered Water (85° - 110°)	1"	1"	1-1/2"
Hot Water Return	1"	1"	1-1/2"
Condensate Waste	1/2"	1/2"	---
Horizontal Storm (Primary)	1/2"	1/2"	3/4"
Horizontal Storm (Secondary) -----Not Required-----			
Underside of Roof Drains	1/2"	1/2"	---
Soil/Waste Piping Above Ceiling (where indicated)	1/2"	1/2"	3/4"

END OF SECTION

SECTION 22 01 10
DRAINAGE SYSTEMS – PLUMBING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the work specified in this Section.

1.2 DESCRIPTION OF WORK

- A. This section includes:
 - 1. Soil and waste piping system work as indicated on drawings and schedules, and by requirements of this section.
 - 2. Applications for soil and waste piping systems include the following:
 - a. Above ground soil, waste and vent piping within buildings including soil stacks, vent stacks, horizontal branches, traps and connections to fixtures and drains.
 - b. Underground building drain piping including mains, branches, traps, connections to fixtures and drains, and connections to stacks, extension from the building, terminating at connection to site sewer.
 - 3. Storm water drainage piping as indicated on drawings and by requirements of this section.
 - 4. Applications for storm water drainage piping include the following:
 - a. Roof drains and connections to gutters, with rain water conductors and connections to underground building storm drains.
 - b. Underground building storm drains, extending and connecting to site drainage system.
 - 5. Insulation for soil and waste and storm water drainage as specified in Section 220030 is included as work of this section.
 - 6. Trenching and backfilling required in conjunction with underground building drainage and site drainage piping as specified in Section 220000 is included as work of this section. Refer to Division I.
 - 7. Installation of detectable metallic underground tape for all exterior buried PVC drainage piping.

1.3 REFERENCE STANDARDS

- A. Refer to Section 220000 for a general description of requirements applying to this section.

1.4 QUALITY ASSURANCE

- A. Refer to Section 220010 for a general description of requirements applying to this section, and a listing of all applicable codes.

1.5 SUBMITTALS

- A. Submit shop drawings and product data in accordance with Section 220000.
- B. Submit the following:
 - 1. Product data on all systems equipment.
- C. See requirements for submission of cross referencing information.

1.6 WARRANTY/GUARANTEE

- A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, GENERAL REQUIREMENTS.

PART 2 – PRODUCTS

2.1 PIPING UNDERGROUND

A. Interior:

1. Sanitary, storm water and condensate waste drainage piping within the building and extending beyond the building wall, unless otherwise noted on the plans, shall be:
 - a. Service weight hub and spigot pattern cast iron soil pipe and fittings with neoprene gaskets.
 - b. Hubless cast iron soil pipe and fittings with cast iron coupling clamps and gaskets or heavy duty 3.04-.016" thick stainless steel bands.
 - c. PVC Schedule 40 pipe and fittings with solvent cement joints.

2. Kitchen Sanitary Drainage and/or Mechanical Room Sanitary Drainage: All Kitchen and/or Mechanical Room sanitary below slab piping and fittings shall be service weight cast iron hub and spigot fitting with butyl rubber gaskets or hubless fittings with heavy duty couplings (no PVC shall be acceptable).

B. Exterior:

1. Stormwater drainage piping 10 inches and smaller, and all sanitary drainage piping unless otherwise noted on the plans, shall be:
 - a. Service weight hub and spigot pattern cast iron soil pipe and fittings, with neoprene gaskets.
 - b. Hubless cast iron soil pipe and fittings with cast iron coupling clamps and gaskets.
 - c. Unplasticized PVC sewer pipe and fittings SDR-35.
2. Stormwater drainage piping 12 inches and larger, shall be:
 - a. Reinforced concrete pipe and fittings.
 - b. Corrugated metal pipe.
 - c. As identified on the drawings.
3. Foundation drainage piping shall be:
 - a. Porous concrete pipe and fittings.
 - b. Perforated PVC pipe and fittings Schedule 40.

2.2 PIPING ABOVE GROUND

A. All above ground storm water, condensate, soil, waste and vent piping shall be:

1. Hubless cast iron soil pipe with cast iron drainage fittings, couplings and stainless steel clamp bands for piping 2" and larger.
2. Copper tubing, type DWV with wrought copper solder type drainage fitting for piping smaller than 2" in size.
3. PVC pipe and fittings type DWV with solvent cement joint connections. (Not permitted in areas of plenum rated ceilings.)

2.3 CONDENSATE WASTE PIPING SYSTEM

A. All aboveground condensate waste piping including connection to equipment shall be:

1. PVC pipe and fittings type DWV with solvent cement joint connections. (Not permitted in areas

- of plenum rated ceilings.)
2. Copper tubing, type DWV with wrought copper solder type drainage fittings.
- 2.4 FLASHING
- A. All vents extending through the roof shall be flashed by the General Contractor. However, the Plumbing Contractor shall furnish and install the necessary counterflashing consisting of a Jay R. Smith Figure 1748 counterflashing fitting, or approved substitute as manufactured by Josam or Zurn. Vents shall terminate 18" above the roof.
- 2.5 SPECIAL EXPANSION COMPENSATION
- A. Special expansion compensation products required for storm, condensate, soil and waste piping systems include the following types:
- B. Cast Iron Drainage System Expansion Joints: Cast-iron body, adjustable bronze sleeve, bronze bolts with wing nuts; for vertical installation only.
- C. PVC Drainage System Expansion Joints: Factory prelubricated "O" ring expansion joint fitting. Installation must be in strict conformance with manufacturer's recommendations.
- D. Available Manufacturers: Subject to compliance with requirements. Manufacturers offering expansion joints which may be incorporated in the work include:
1. Cast Iron Piping Systems - J.R. Smith or approved substitute.
 2. PVC Piping Systems – George Fisher or approved substitute.
- 2.6 SYSTEMS EQUIPMENT
- A. Refer to Plumbing Fixture and Equipment Schedule for type, number, size and manufacturer of all drainage equipment and accessories.
- B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering drainage equipment which may be incorporated in the work are limited to the following:
- Floor Drains (all types)
- Zurn
- Josam
- Wade
- Watts
- Smith
- MIFAB
- Roof Drains
- Zurn/Froet
- Josam
- Wade
- Watts
- Smith
- MIFAB
- Cleanouts
- Zurn
- Josam

Wade

Watts

Smith

MIFAB

Interceptors

Zurn

Josam

Wade

Watts

Smith

Woodford

MIFAB

Backwater Valves & Traps (Cast Iron)

Zurn

Josam

Wade

Watts

Smith

Red Valve Co.

MIFAB

Wall Spout Nozzles

Zurn/Froet

Josam

Wade

Watts

Smith

MIFAB

C. Cross Reference Identification:

1. If the Contractor selects a manufacturer of drainage equipment products other than as identified on the Schedule but is selected from the available manufacturers listed above, a cover sheet shall be included with the submission of shop drawings indicating the cross-referenced manufacturer and model number.
2. Shop drawings shall not be reviewed or accepted if not in compliance with this requirement.

PART 3 – EXECUTION

3.1 INSTALLATION OF SOIL AND WASTE PIPING

- A. The Plumbing Contractor shall install a complete system of sanitary drainage piping as shown on the drawings. All drainage lines shall be properly run, trapped and vented in accordance with the local Plumbing Code and all dry vents, back vents, loop vents, revents or special vents required by the Code shall be furnished and installed by the Plumbing Contractor.
- B. Drainage lines of the sizes shown on the drawings shall be extended within the building with

branches connecting to the base of all soil, waste and vent stack, etc., leaving outlets for connection to all fixtures, floor drains, as required.

- C. All changes in direction of drainage piping shall be installed with "Y" branches and 1/8 bends. All stacks shall be supported with concealed pipe clamps or hangers as required and the openings in the roof for the vent pipes will be provided by this Contractor.
- D. All drainage piping which will be located above suspended ceilings shall be checked for slope to assure positive drainage, prior to installation of the ceilings. Pressure tests for leaks, as hereinafter specified, shall also be performed prior to ceiling installation.
- E. Install soil and vent piping pitched to drain at minimum slope of 1/4" per foot (2%) for piping 2-1/2" and smaller, and 1/8" per foot (1%) for piping 3" and larger.
- F. Vertical to horizontal change in direction to be made with long radius fittings.
- G. Support all soil and waste piping per IPC Section 308.5, 308.6 and 308.7.
- H. All hangers, anchors, support and guides for piping, and equipment shall be securely fastened to the building structure and/or floors with concrete decking with the following exception. Hangers, anchors, support and guides shall not be fastened to or through metal roof decking (i.e. bare metal decking or metal deck supporting a roofing system).
- I. Provide exterior clean-out on both sanitary and storm drain mains. Minimum size shall be 4" installed within 5 ft. of the building. (Also see Paragraph 3.5).

3.2 INSTALLATION OF STORM WATER DRAINAGE PIPING

- A. Connect piping to roof drains and outlets provided in gutters, install rainwater conductors and extend to underground storm building drains as indicated.
- B. Underground storm building drains shall be extended from the building, terminating beyond the building wall.
- C. Provide exterior clean-out on both sanitary and storm drain mains. Minimum size shall be 4" installed within 5 ft. of the building. (Also see Paragraph 3.5).
- D. Connect to exterior downspouts, install cast iron downspout shoes, and extend piping from the building wall.
- E. All changes in direction of drainage piping shall be installed with "Y" branches and 1/8 bends. All stacks shall be supported with concealed pipe clamps or hangers as required, and the openings in the roof for the vent pipes will be provided by this Contractor.
- F. All drainage piping which will be located above suspended ceilings shall be checked for slope to assure positive drainage, prior to installation of the ceilings. Pressure tests for leaks, as hereinafter specified, shall also be performed prior to ceiling installation.
- G. Install storm water drainage piping pitched to drain at minimum slope of 1/8" per foot (1%) for piping 4" and larger.
- H. Vertical to horizontal change in direction to be made with long radius fittings.
- I. All hangers, anchors, support and guides for piping, and equipment shall be securely fastened to the building structure and/or floors with concrete decking with the following exception. Hangers, anchors, support and guides shall not be fastened to or through metal roof decking (i.e. bare metal decking or metal deck supporting a roofing system).

3.3 INSTALLATION OF CONDENSATE DRAINAGE PIPING

- A. Connect piping to HVAC equipment and/or appliance requiring condensate drainage and extend to condensate risers and/or underground storm building drainage as indicated. (Extend condensate drainage discharge to the back of exterior downspouts or to exterior grade where indicated.)

- B. Underground condensate building drains shall be extended to underground storm building drainage or from the building, terminating beyond the building wall where indicated.
- C. Provide clean-outs on condensate drainage where indicated. Condensate drainage piping shall be configured to permit the cleaning of blockages and performance maintenance without requiring piping to be cut.
- D. All changes in direction of condensate drainage piping sizes 1-1/4" and above shall be installed with "Y" branches and 1/8 bends.
- E. All condensate drainage piping shall be hung and/or supported in accordance with the plumbing code. All stacks/risers shall be supported with concealed pipe clamps or hangers as required. (Where indicated the openings in the roof for the vent pipes will be provided by this contractor.)
- F. All condensate drainage piping which will be located above suspended ceilings shall be checked for slope to assure positive drainage, prior to installation of the ceilings. Pressure tests for leaks, as hereinafter specified, shall also be performed prior to ceiling installation.
- G. Install condensate drainage piping pitched to drain at minimum slope of 1/8" per foot (1 percent slope.)
- H. Condensate piping shall be trapped where, and as required, by HVAC equipment and/or appliance manufacturer. Provide trap in accordance with HVAC equipment and/or appliance manufacturer.
- I. Condensate piping shall be provided with an upright back water valves as indicated and/or where condensate piping connects to storm drainage (via direct connection to above ground storm piping or underground storm drainage piping.) or as required by, and in accordance with, HVAC equipment or appliance manufacture (i.e. ductless mini-split systems.) Where condensate backwater valves are installed, they shall be installed on above ground vertical piping in the vertical position in the direction of drain flow and in areas with access for inspection and maintenance.
- J. After the completed installation (including inspection and testing) and before placing connected HVAC and/or appliances into service, condensate piping shall be flushed with water for a period of approximately 10 to 15 minutes to remove construction debris, left-over solder flux, etc. and to verify proper operation. (Where non-water-based flux is use, flush with hot water.)
- K. All hangers, anchors, support and guides for piping, and equipment shall be securely fastened to the building structure and/or floors with concrete decking with the following exception. Hangers, anchors, support and guides shall not be fastened to or through metal roof decking (i.e. bare metal decking or metal deck supporting a roofing system).

3.4 INSTALLATION OF SPECIAL EXPANSION COMPENSATION PRODUCTS

- A. Expansion Joints: Install expansion joints on vertical risers as indicated, and/or as required by International Plumbing Code.
- B. PVC piping systems in multi-story (four stories or more) shall require "O" ring expansion joints to compensate for length changes in soil, waste and vent stacks. Expansion joints shall be required at every floor level for soil and waste stack and at alternate floors for vent stacks and rainwater conductors.

3.5 INSTALLATION OF CLEANOUTS

- A. Cleanouts: Install in sanitary piping and storm conductor and building drain piping as indicated, and/or as required by International Plumbing Code; at each change in direction of piping greater than 45 degrees; at minimum intervals of 100' for all size straight run piping; and at base of each conductor. Install floor and wall cleanout covers for concealed piping, select type to match adjacent

building finish.

- B. Exterior cleanouts shall be installed with access covers flush to grade. The cleanout shall be installed within a concrete pad, 18"x18"x6" thick.

3.6 INSTALLATION OF FLOOR DRAINS (ALL TYPES)

- A. Install floor drains in accordance with manufacturer's written instructions and in locations indicated.
- B. Install floor drains at low points of surface areas to be drained, or as indicated. Set tops of drains flush with finished floor.
- C. Install drain flashing collar or flange so that no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes, where penetrated.
- D. Position drains so that they are accessible and easy to maintain.
- E. All exposed drainage piping shall be DWV copper pipe and fittings. All piping shall be rigidly supported off the wall with split ring clamps or uni-strut.

3.7 INSTALLATION OF ROOF DRAINS

- A. Install drains in accordance with manufacturer's written instruction and in location indicated.
- B. Coordinate with roofing as necessary to interface roof drains with roofing work.
- C. Install drains at low points of surface areas to be drained, or as indicated.
- D. Install drain flashing collar or flange so that no leakage occurs between drain and adjoining roofing. Maintain integrity of waterproof membranes, where penetrated.
- E. Position drains so that they are accessible and easy to maintain.
- F. The roof drain specified is a combination "Primary and Secondary" arrangement. Verify the correct outlet connections to their respective systems.

3.8 INSTALLATION OF INTERCEPTORS

- A. Install interceptors in accordance with manufacturer's written instruction and in location indicated.
- B. Install flow control fitting where indicated on the drawing and/or diagrams including vent relief piping.
- C. Interceptors shall be vented in accordance with the local plumbing code and as indicated on the drawings.

3.9 INSTALLATION OF FOUNDATION DRAINAGE

- A. Each section of foundation drainage piping shall be extended up, to a cleanout at grade. Piping shall pitch toward the connection to the stormwater drainage system.
- B. Piping shall be laid on minimum of 6 inches No. 8 aggregate crushed stone, and backfill shall be done as detailed on the drawings. Crushed stone shall be washed. Aggregate shall be of the sizes indicated and in accordance with ASTM standards. Stone fill layer shall be carefully placed to the indicated depth without disturbing the pipe alignment and a layer of untreated building paper or 2 inches of salt hay placed on top of the stone, the full width of the trench. Remaining earth fill shall be mounded at top to allow for settlement.

3.10 UNDERGROUND METALLIC TAPE

- A. All exterior underground PVC drainage piping (sanitary, storm, condensate waste) shall be provided with detectable metallic underground tape.
- B. Tape shall be similar to Lineguard Maintenance Systems as provided by Utility Supply of America 800-548-1234 or approved substitute as manufactured by Seton.
- C. Installation shall comply with manufacturer's recommendations and shall be installed in the backfill

after refilling the trench opening completely, and allowed to settle to the desired 4" to 6" depth. The Contractor shall install the tape after final lifts in compaction backfilling or unroll it before final restoration or installation of sod, black dirt, seeding, etc.

- D. The tape system shall be installed under the supervision of the Owner's Representative. When the tape system is complete, the Contractor shall provide a test using the tape manufacturer's recommended detection device, to prove the integrity of the installation with the Owner's Representative.

3.11 INVERTS AND ELEVATIONS

- A. Indicated inverts and elevations of existing utilities are approximate and based on the best information available. Upon award of Contract, Contractor shall verify in the field all such information and report any discrepancies to the Engineer before proceeding with work.

3.12 PIPING INSTALLED IN FILLED GROUND

- A. Piping located below floor slab in filled areas shall be supported either from the floor slab, or with masonry piers to undisturbed earth. Drainage piping shall be supported at each joint. Exterior piping located in filled areas shall be supported with piers.
- B. Details of supports and method of installation shall meet with the approval of the Engineer.

3.13 INSPECTION

- A. The Plumbing Contractor shall, upon completion of the drainage systems, secure from the Inspector and/or the Municipality under which the installation was made and inspected, certificates or letters of approval indicating the system has been installed satisfactorily. The Plumbing Contractor shall certify that all inspection fees, permits and charges have been duly paid.

END OF SECTION

SECTION 22 01 20
DOMESTIC WATER SYSTEMS – PLUMBING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the work specified in this Section.

1.2 DESCRIPTION OF WORK

- A. This Section includes:
 - 1. Domestic water piping systems work is indicated on drawings and schedules and by requirements of this section.
- B. Applications for water piping systems include the following:
 - 1. Exterior water service piping from connection 5'-0" beyond building foundation to building domestic water piping.
 - 2. Exterior fire/sprinkler service from connection 5'-0" beyond building foundation to flanged connection 12" above finished floor slab in Mechanical/Boiler Room.
 - 3. Domestic cold-water piping.
 - 4. Domestic hot-water piping.
 - 5. Domestic recirculating-water piping.
- C. Complete flow balancing of the entire domestic hot water return system.
- D. Insulation for domestic water piping as specified in Section 220030 is included as work of this section.
- E. Trenching and backfill required in conjunction with exterior water piping as specified in Section 220000 is included as work of this section. Refer to Division 1.

1.3 REFERENCE STANDARDS

- A. Refer to Section 220000 for a general description of requirements applying to this section.

1.4 QUALITY ASSURANCE

- A. Refer to Section 220010 for a general description of requirements applying to this section.

1.5 SUBMITTALS

- A. Submit shop drawings and product data in accordance with Section 220000.
- B. Submit the following:
 - 1. Product data on all specialties and systems equipment.

1.6 WARRANTY/GUARANTEE

- A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, GENERAL REQUIREMENTS.

PART 2 – PRODUCTS

2.1 DOMESTIC WATER PIPING MATERIALS AND PRODUCTS

- A. Provide piping materials and factory fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in

domestic water piping systems. Where more than 1 type of materials or products are indicated, selection is Installer's option.

2.2 BASIC PIPE, TUBE AND FITTINGS

- A. Provide pipe, tube, and fittings complying with Division 22 Basic Materials and Methods section "Pipe, Tube, and Fittings", in accordance with the following listing:

- B. Interior Domestic Water Piping:

Tube Size 4" and Smaller: Copper tube.
Wall Thickness: Type "L" hard-drawn temper.
Fittings: Wrought-copper, solder-joints.

- C. Exterior Water Service Piping:

Pipe Size 3" and Smaller: Copper tube.
Wall Thickness: Type "K" Soft Temper
Fittings: Wrought copper solder joint.
Pipe Size 4" and Over: Ductile-iron pipe with cement-mortar lining, and gasketed joints.
Pipe Weight: Schedule 150.
Fittings: Ductile-iron, with cement-mortar lining, mechanical joint.
Pipe Size 3" and Smaller: Polyvinyl Chloride (PVC)
ASTM 1785
Wall Thickness: Schedule 80.
Fittings: PVC with Schedule 80, socket-type solvent joints or elastomeric gasketed joints.
Pipe Size 4" to 12": Polyvinyl Chloride (PVC)
AWWA C900
Pipe Class: Class 150
Fittings: Molded pressure Class 150 with AWWA C907, gaskets conforming to ASTM F-477.

- D. Polypropylene Random Co-Polymer (PP-R) pipe and fittings. See specification section 22 01 21 (PP-R) Domestic Water Piping (Basis of Design).

2.3 BASIC PIPING SPECIALTIES

- A. Provide piping specialties complying with Section 220010 Basic Materials and Methods in accordance with the following listing:

Pipe escutcheons
Dielectric unions
Drip pans
Pipe sleeves
Sleeve seals

2.4 SPECIAL PIPING SPECIALTIES

- A. Water Hammer Arresters: Provide bellows or piston type water hammer arresters, pressure rated for 250 psi, tested and certified in accordance with PDI Standard WH-201.

2.5 BASIC VALVES

- A. Provide valves complying with applicable Division 22 sections "Valves", in accordance with the following listing:
- B. Sectional Valves:
 - 2-1/2" and Smaller: Ball Valves.
Gate Valves.
 - 3" and Larger: Ball Valves.
Butterfly Valves.
- C. Shutoff Valves:
 - 2-1/2" and Smaller: Ball Valves.
Gate Valves
 - 3" and Larger: Ball Valves.
Butterfly Valves.
- D. Drain Valves:
 - All Hose End Threaded Gate or Ball Valves.
- E. Balancing Valves:
 - 2" and Smaller: Ball Valves (Circuit Setter Type).
(w/ Memory Stop)
- F. Check Valves:
 - All Sizes: Swing Check Valves. Horizontal Installations
Spring Check Valves. Vertical Installations

2.6 WATER METER

- A. Provide water meter and related piping conforming to applicable local Utility Company regulations and AWWA Standards.
- B. Water Meter: Provided by Local Utility Company. Provide roughing-in and bypass for meter in accordance with Utility Company requirements.

2.7 SPECIAL VALVES

- A. Special valves required for domestic water piping systems include the following types:
- B. Hose Bibbs: Threaded end, renewable composition disc, tee handle, 3/4" NPT inlet, 3/4" hose outlet with vacuum breaker.
 - 1. Finished Areas: Chrome plated.
 - 2. Unfinished Areas: Bronze finish.
- C. Wall Hydrants: Non-freeze, cast-bronze body, tee handle key, bronze casing, length to suit wall thickness, vacuum breaker, hinged locking cover, 3/4" inlet, hose outlet.

2.8 BASIC THERMOMETERS AND GAUGES

- A. Provide thermometers and gauges complying with Division 22 Basic Materials and Methods Section "Meters and Gauges", in accordance with the following listing:
 - Pressure gauges
 - Glass thermometers
 - Pressure and temperature connections

2.9 BASIC PUMPS

- A. Provide pumps as specified in applicable Section 220150 Equipment - Plumbing. Use inline pumps for hot water recirculating.

2.10 BACKFLOW PREVENTERS

- A. Provide, of the type indicated on the drawing schedule, reduced pressure principal type, backflow preventers shall consist of an assembly including shutoff valves on inlet and outlet, and strainer on inlet. Backflow preventers shall include test cocks, and pressure-differential relief valve located between two positive seating check valves. Construct in accordance with ASSE Standard.
- B. On dead-end services (HVAC make-up) provide a spring-loaded check valve ahead of the backflow preventer assembly.

2.11 SYSTEMS EQUIPMENT MANUFACTURERS

- A. Refer to Plumbing Fixture and Equipment Schedule for type, number, size and manufacturer of all equipment and accessories.
- B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering equipment which may be incorporated in the work are limited to the following:

Shock Absorbers:

Zurn

Josam

Wade

Watts

Smith

PPP Inc.

MIFAB

Hose Bibbs

Nibco

Tanner

Central Brass

Wolverine

Wall Hydrants

Zurn

Josam

Wade

Watts

Smith

Woodford

MIFAB

Backflow Preventers (including RPZ type)

Conbraco

Febco

Cla-Val

Wilkins

ITT Grinnell

Neptune

Watts

Relief Valves

Rockwell

Fisher

DeZurik

Pressure Reducing Valves

Conbraco

Jamesbury

DeZurik

Fisher

ITT Bell & Gossett

- 2.12 SEE SPECIFICATION SECTION 22 01 21: ALTERNATE (PP-R) DOMESTIC WATER PIPING FOR ALTERNATIVE DOMESTIC WATER PIPING AND FITTINGS

PART 3 – EXECUTION

3.1 INSTALLATION OF BASIC IDENTIFICATION

- A. Install mechanical identification in accordance with Section 220010 Basic Materials and Methods.
- B. Support vertical piping at floor levels using approved riser clamps. Clamp material shall be compatible with pipe material. Maximum vertical spacing shall be 10'-0". Domestic water piping shall be supported in accordance with the International Mechanical Code, Section 305 and Table 305.4 Spacing Intervals, or in accordance with MSS-SP-69. International Plumbing Code's latest edition, Section 308.5, accept as follows:
 - 1. Copper tubing ½" to 1-1/4" nominal size, not to exceed 6 ft. horizontal intervals.
 - 2. Copper tubing 1-1/2" and larger nominal size, not to exceed 10 ft. horizontal intervals.
 - 3. Copper tubing ½" to 1-1/4" nominal size, not to exceed 10 ft. vertical intervals.
 - 4. Copper tubing 1-1/2" and larger nominal size not to exceed 10 ft. vertical intervals.
 - 5. CPVC pipe or tubing ¼" to 1" nominal size, not to exceed 3 ft. horizontal spacing.
 - 6. CPVC pipe or tubing 1-1/4" and larger nominal size not to exceed 4 ft. horizontal spacing.
 - 7. CPVC pipe or tubing ¼" to 1" nominal size not to exceed 10 ft. vertical.
 - 8. CPVC pipe or tubing 1-1/4" and larger nominal size not to exceed 10 ft. vertical."

*Mid-Story Guide.

3.2 INSTALLATION OF DOMESTIC WATER SERVICE SYSTEM - BUILDING

- A. Install water distribution system in accordance with Section 220010 Basic Materials and Methods, and the International Mechanical Codes Section 305, and Support Intervals under Tables 305.4 and 308.5 or in accordance with MSS-SP-69.
- B. All hangers, anchors, support and guides for piping, and equipment shall be securely fastened to the building structure and/or floors with concrete decking with the following exception. Hangers, anchors, support and guides shall not be fastened to or through metal roof decking (i.e. bare metal decking or metal deck supporting a roofing system).

3.3 REACTION BACKING

- A. All plugs, tees and elbows in the underground piping shall be provided with reaction backing consisting of concrete placed between solid undisturbed earth and the fitting to be anchored. Concrete shall be of such bearing area as to assure adequate resistance to the thrust to be encountered. In general, backing shall be so placed that the joint will be accessible for inspection and repair.

3.4 INSTALLATION OF VALVES

- A. Install valves in accordance with Division 22 Basic Materials and Methods section, "Valves".
- B. Sectional Valves: Install on each branch and riser, close to main, where branch or riser serves 2 or more fixtures, equipment connections, and elsewhere as indicated.
- C. Shutoff Valves: Install on inlet of each plumbing equipment item, and on inlet of each plumbing fixture, and elsewhere as indicated.
- D. Drain Valves: Install on each plumbing equipment item located to completely drain equipment for service or repair. Install at base of each riser, at base of each rise or drop in piping system, and elsewhere where indicated or required to completely drain domestic water piping system.
- E. Check Valves: Install on discharge side of each pump, and elsewhere as indicated.
- F. Balance Cocks: Install in main recirculating loop and in each branch hot water recirculating loop. Install a ball valve and check valve at each balance valve installation.
- G. Hose Bibbs: Install on exposed piping where indicated, with vacuum breaker.

3.5 INSTALLATION OF BACKFLOW PREVENTERS

- A. Install backflow preventers where indicated, and where required by International Plumbing Code. Locate in same room or area as equipment being protected.
- B. RPZ type backflow preventers to be piped from the relief outlet to nearest floor drain.
- C. A check valve is required on the upstream side of all RPZ installations.

3.6 INSTALLATION OF EXPANSION COMPENSATION PRODUCTS

- A. This project shall require the installation of expansion compensators.
- B. Furnish and install expansion compensation products in accordance with Section 220210 Basic Materials and Methods – HVAC

3.7 INSTALLATION OF THERMOMETERS AND GAUGES

- A. Install thermometers and gauges in accordance with Section 220010 Basic Materials and Methods.

3.8 INSTALLATION OF WATER METER

- A. Install water meter in accordance with Section 220010 Basic Materials and Methods.
- B. Meter shall be supported in accordance with the requirements of the Water Department.

3.9 EQUIPMENT CONNECTIONS

- A. Piping Runouts to Fixtures: Provide hot and cold water piping runouts to fixtures of sizes indicated, but in no case smaller than required by International Plumbing Code.
- B. Equipment furnished by the Owner or Contractors other than this Contractor: After equipment has been set in place, this Contractor shall furnish all labor and material required to make final connections, between roughing-in and the equipment. Install valves, fittings, trim and appurtenances furnished with the equipment. All exposed piping in the kitchen areas shall be chrome plated. Piping in other areas shall be of the same material as the system to which it connects.

3.10 SPARE PARTS

- A. Furnish to Owner, with receipt, one valve key for each key operated hydrant, bibb, or faucet installed.

3.11 INSTALLATION OF EXTERIOR WATER PIPING (5'-0" EXTENSIONS)

- A. Install exterior water service piping system in compliance with local governing regulations.
- B. Main Connections: Coordinate all work with the Site Contractor. The Plumbing Contractor shall make final connections of the domestic and fire protection water services.
- C. Water Service Piping: From the final connection points, extend water service piping of size and in locations indicated to the water service entrance in building. Provide ball valve at the domestic water service and a flanged connection with a ¾" blow-off valve for the fire protection water service (12" A.F.F.).
- D. Ductile-Iron Pipe: Install in accordance with ANSI/AWWA C-60.
- E. Test:
 - 1. Domestic Water Service: Minimum 125 psi.
 - 2. Fire Protection Water Service: Minimum 200 psi.
 - 3. Combination Domestic & Fire Protection Water Service: Minimum 200 psi.
- F. Sterilization: At completion of water service line installation, flush and sterilize in conformance with AWWA C-601, to satisfaction of local Authorities Having Jurisdiction.

3.12 KITCHEN DOMESTIC WATER

- A. All kitchen domestic water system piping shall be roughed-in and strictly coordinated with the kitchen equipment drawings.
- B. Provide all rough-in piping and final connections to equipment furnished by the Kitchen Equipment Contractor (KEC). This also includes any equipment items furnished by the KEC and are to be completely installed by the Plumbing Contractor.
- C. Verify all responsibilities during the bid phase of the work.
- D. All piping shall be supported off the wall with split ring clamps or uni-strut.
- E. All piping shall be insulated and identified.
- F. Provide shut-off valves and stainless-steel flex hose connections to all individual equipment connections.
- G. All exposed piping shall be chrome plated brass.

3.13 DOMESTIC HOT WATER RETURN

- A. This Contractor shall install complete and operating hot water return system. The system shall be balanced and include a report as required in HVAC Specification Section 230950.
- B. Balancing Valves are required in the system as hereinbefore specified. The system shall also include the installation of "air bleed" or "burp" valves to remove any trapped air in the system.
- C. Where emergency showers are installed with thermostatic mixing valve, they shall require the installation of a hot water return line as detailed on the drawings.

END OF SECTION

SECTION 22 01 21

(PP-R) DOMESTIC WATER PIPING (Basis of Design)

PART 1 – GENERAL

1.1 SUMMARY

- A. The section specifies the water distribution piping system, including potable cold, hot, and re-circulated hot water piping including associated fittings, and specialties within the building.

1.2 RELATED SECTIONS

- A. Drawings and general provisions of the Contract, including General Conditions, Supplementary Conditions, General Requirements, and Division 22 – Plumbing Specification Sections apply to work of this section.

1.3 REFERENCE DOCUMENTS

- A. ASTM F 2389-21 – Standard Specification for Pressure-rated Polypropylene (PP-RCT) Piping Systems
- B. CSA B137.11 – Polypropylene (PP-R) Pipe and Fittings for Pressure Applications.
- C. ANSI/NSF 14 – Plastic Piping System Components and Related Materials.
- D. ANSI / NSF 61 – Drinking Water Systems Components – Health Effects
- E. ANSI / NSF 51 – Food Equipment Materials

1.4 DEFINITIONS

- A. Definitions shall be in accordance with local plumbing codes and ASTM F 2389-21.

1.5 SUBMITTALS

- A. Material list naming each product to be used identified by manufacturer with product number, in accordance with Section 013300.

1.6 QUALITY ASSURANCE

- A. Material shall be certified by NSF as complying with NSF 14, NSF 61, NSF 51, ASTM F 2389-21, and CSA B137.11.
- B. Material shall comply with manufacturers specifications.
- C. NSF shall certify special engineered products as complying with NSF 14, NSF 61, and NSF 51.

PART 2 – PRODUCTS

2.1 PIPE AND PIPING PRODUCTS

- A. Pipe shall be manufactured from a high quality Polypropylene Random Co-Polymer produced using Borealis RA-7050 “Beta (β) nucleated (hexagonal crystalline structure) PP-RCT resin, meeting the short-term properties and long-term strength requirements of ASTM F 2389-21. The pipe shall contain no rework or recycled materials and manufactured only from “virgin” resins. All pipes shall be made in a three-layer extrusion process. Domestic hot water piping shall have a central Powercore™ layer containing added fiberglass (to reduce thermal expansion). All pipes shall comply with the rated pressure requirements of ASTM F 2389-21. All pipe shall be certified as complying with NSF 14, NSF 61, NSF 51, ASTM F 2389-21 and CSA B137.11.
- B. Hot water pipe shall be NUPI Americas NIRON Clima PP-RCT with a central Powercore™ layer containing added fiberglass (to reduce thermal expansion), for domestic hot water available from NUPI Americas. Piping material specifications and ordering information are available at www.nupiamericas.com
- C. Cold water pipe shall be NUPI Americas NIRON Clima PP-RCT with a central Powercore™ layer containing added fiberglass (to reduce thermal expansion), for domestic cold water available from

NUPI Americas. Piping material specifications and ordering information are available at www.nupiamericas.com

2.2 FITTINGS

- A. Injection molded fittings shall be provided on all fittings through 12" diameter unless otherwise approved as a "custom fitting" and shall be produced using Borealis RA-7050 Beta – nucleated (hexagonal crystal structure) PP-RCT resin. The fittings shall contain no rework or recycled materials and manufactured only from "virgin" resins by NUPI Americas. All fittings shall be certified by as complying with NSF 14, NSF 6 and ASTM F 2389 or CSA B137.11. Fitting material specifications and ordering information are available at www.nupiamericas.com
- B. Fittings larger than 12" diameter shall be fabricated by NUPI Americas using the same piping material furnished for the piping application and complying with NSF 14, NSF 61, NSF 51 and ASTM F 2389-21 or CSA B137.11. Fitting material specifications and ordering information are available at www.nupiamericas.com

2.3 WARRANTY

- A. Manufacturer shall warrant pipe and fittings for 30 years to be free of defects in materials and workmanship.

2.4 SMOKE AND FIRE RATINGS

- A. Where indicated on the drawings that a Plenum-rated Piping System is needed, then the pipe shall be wrapped and/or insulated with standard pipe insulation, field installed. The pipe wrap or insulation shall meet the requirements of CAN/ULC-S102.2-03 or ASTM E84. The system shall have a Flame Spread Classification of less than 25 and Smoke Development rating of less than 50.

2.5 UV PROTECTION

- A. Where indicated on the drawings that the pipe will be exposed to direct UV light for more than 30 days PP-RCT Pipe, fittings, and valves shall contain no rework or recycled materials. Pipe shall be manufactured from a beta crystalline polypropylene-random copolymer (PP-RCT) thermoplastic material. The pipe shall be coextruded as a three-layer pipe with a central Powercore™ layer containing added fiberglass (to reduce thermal expansion), and an outer layer that is made from a "white" only, (heat gain limiting), 30-year UV-resistant PPR (polypropylene-random copolymer material), with heat-fused connections and naturally corrosion-resistant properties. Fittings shall be made from white 30-year UV-resistant PP-RCT material, except for fittings having a small surface area.
- B. Manufacturer shall warrant pipe and fittings for 30 years to be free of defects in materials or manufacturing. Pipe and fittings shall be Niron Clima Cool-pro™ "white" 30-year UV-resistant as manufactured by Nupi Americas, or approved equal. Coating or painting of pipe is not acceptable.

2.6 THERMAL AND VAPOR BARRIER

- A. Where standard pipe insulation is indicated on the drawings or in these specifications, the contractor shall provide a thermal (radiant, conductive, and convective) and vapor barrier insulation. The insulation products shall be as indicated on the drawings or elsewhere in these specifications. The standard pipe insulation shall be UV resistant, CFC-free, non-porous, non-fibrous, and resist mold growth. The pipe with the insulation shall meet the ASTM E84 and the CAN/ULC S102.2 requirements for a Flame Spread Rating of 25 and Smoke Development rating of 50.

PART 3 – EXECUTION

3.1 PIPING APPLICATIONS

- A. Install listed pipe materials and joining methods below in the following applications:
 - 1. Underground Piping: Polypropylene (PP-RCT) piping in SDR 7.3, SDR 9, SDR 11 or SDR 17 or as noted by Engineer and installed as per manufacturer's instructions and ASTM D2774.

2. Aboveground Piping: Polypropylene (PP-RCT) piping in SDR 7.3, based on the required minimum pressure rating and use temperature or as noted by Engineer, in accordance with manufacturer's instructions and ASTM F2389-17. Hot water service to be SDR 7.3 only.

3.2 FUSION WELDING OF JOINTS

- A. Install fittings and joints using socket-fusion, electro-fusion, or butt-fusion as applicable for the fitting type. All fusion-weld joints shall be made in accordance with the pipe and fitting manufacturer's specifications and product standards.
- B. Fusion-weld tooling, welding machines, and electrofusion devices shall be as specified by the pipe and fittings manufacturer.
- C. Prior to joining, the pipe and fittings shall be prepared in accordance with ASTM F 2389-17 and the manufacturer's specifications.
- D. Joint preparation, setting and alignment, fusion process, cooling times and working pressure shall be in accordance with the pipe and fitting manufacturer's specifications.

3.3 PIPING INSTALLATIONS

- A. Install hangers and supports at intervals specified in the applicable Plumbing Code and as recommended by pipe manufacturer.
- B. Support vertical piping at each floor and as specified in the applicable Plumbing Code.
- C. Fire stopping shall be provided to both be compatible with the Nupi Piping and meet the requirements of ASTM E 814 or ULC S115, "Fire Tests of Through-Penetration Firestops". Pipe insulations or fire resistive coating shall be removed where the pipe passes through a fire stop and, if required by the firestop manufacturer, for 3 inches beyond the firestop outside of the fire barrier.
- D. When installed in systems with pumps in excess of 7.5 HP, piping shall be protected from excessive heat generated by operating the pump at shut-off conditions. Where the possibility exists that the pump will operate with no flow, the protection method shall be a temperature relief valve or comparable level of protection, set to a maximum temperature of 185°F.
- E. If heat tracing is specified for the piping, it shall be installed on the pipe exterior, and it must be suitable for use with plastic piping and self-regulating to ensure the surface temperature of the pipe and fittings will not exceed 70°C (158°F).

3.4 INSPECTING AND CLEANING

- A. The pipes should be flushed with cold water after finishing the installation. Inspect and test piping systems following procedures of authorities having jurisdiction and as specified by the piping system manufacturer.
- B. Clean and disinfect water distribution piping following procedures of the authority having jurisdiction.

3.5 PIPE SUPPORT AND HANGER SPACING

- A. HORIZONTAL SUPPORT SPACING

RECOMMENDED SUPPORT SPACING FOR NIRON CLIMA AND COOLPRO SDR 7.3 PIPING

Design temp	½" 20mm	¾" 25mm	1" 32mm	1¼" 40mm	1½" 50mm	2" 63mm	2½" 75mm	3" 90mm	4" 110mm	5" 125mm	6" 160mm	8" 200mm	10" 250mm	12" 315mm
70°F	4	4.5	5	6	6.5	7.5	8	8	9	10	10	10	10	12
80°F	4	4	4.5	5.5	6	7	7	7.5	8	9	9.5	9.5	9.5	11
90°F	4	4	4	5	5.5	6.5	6.5	7	7.5	8.5	9	9	9.5	10
100°F	4	4	4	4.5	5	6	6	6.5	7	8	9	9	9	10
110°F	4	4	4	4.5	5	5.5	6	6.5	7	7.5	8	8	8.5	9
120°F	4	4	4	4	5	5.5	6	6	7	7.5	8	8	8	9
130°F	4	4	4	4	5	5.5	5.5	6	6.5	7	7.5	7.5	8	8.5
140°F	4	4	4	4	4.5	5.5	5.5	6	6.5	7	7.5	7.5	8	8.5
150°F	4	4	4	4	4.5	5	5.5	6	6	6.5	7	6.5	7	7.5
160°F	4	4	4	4	4.5	5	5.5	6	6	6	6.5	6.5	7	7.5
170°F	4	4	4	4	4.5	5	5	5.5	5.5	6	6	6.5	6.5	7
180°F	4	4	4	4	4	5	5	5.5	5.5	6	6	6.5	6.5	7
190°F	4	4	4	4	4	4.5	5	5	5.5	6	6	6	6	6.5
200°F	4	4	4	4	4	4.5	5	5	5	5.5	6	6	6	6.5

B. SUPPORTING NIRON PIPING IN VERTICAL POSITIONS

1. When supporting Niron Clima PP-RCT piping in vertical positions, the piping must be provided vertical guides at a distance not to exceed 1.5 times the ordinary support spacing at the system design temperature. The piping should also be supported from either the top, or the bottom of the piping system at a minimum so as to support the weight of the column of fluid. Further, it is a common requirement that the piping be provided with anchors (riser clamps) at various floors as the piping extends through the building. In some applications, the piping may be anchored by the means of riser clamps at every floor as a conservative measure.
2. If the height of the floor is less than 1.5 times the standard horizontal support spacing at the design temperature, then it is not necessary to provide intermediate guides in the mid span position of the pipe. However, if the value of 1.5 times the ordinary support spacing at the system design temperature is less than the height of the individual floor in question, then a mid-span support must be positioned on the pipe to act as a vertical guide. This mid-span guide typically would be located approximately in the middle of the span.

END OF SECTION

SECTION 22 01 30
GAS PIPING SYSTEMS – PLUMBING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the work specified in this Section.

1.2 DESCRIPTION OF WORK

- A. This Section includes:
 - 1. Natural gas piping system as indicated on drawings and schedules, and by requirements of this section.
 - 2. Applications for natural gas piping systems include the following:
 - a. Gas service from street main to building meter by Chesapeake Gas Division.
 - b. Elevated pressure (psi) gas from meter location to rooftop gas-fired equipment.
 - c. Low pressure (WC) from the meter location to all other equipment and outlets, requiring gas service.
 - 3. Trenching and backfill required in conjunction with exterior gas distribution as specified in Section 220000 is included as work of this section. Refer to Division 1.

1.3 REFERENCE STANDARDS

- A. Refer to Section 220000 for a general description of requirements applying to this Section.

1.4 QUALITY ASSURANCE

- A. Refer to Section 220010 for a general description of requirements applying to this section.

1.5 SUBMITTALS

- A. Submit shop drawings and product data in accordance with Section 220000.
- B. Submit the following:
 - 1. Product data on gas valves.

1.6 WARRANTY/GUARANTEE

- A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, GENERAL REQUIREMENTS.

PART 2 – PRODUCTS

2.1 NATURAL GAS PIPING MATERIALS AND PRODUCTS

- A. Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, and capacities as indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide materials and products complying with ANSI B31.2 where applicable, base pressure rating on natural gas piping system maximum design pressures. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match piping materials used in natural gas piping systems. Where more than 1 type of material or product is indicated, selection is Installer's option.

2.2 BASIC IDENTIFICATION

- A. Provide identification complying with Division 22 Sections and in accordance with the following listing:

Building Distribution Piping: Plastic pipe markers.

Gas Service: Underground type plastic line markers with detectable wire..

Gas Valves: Plastic valve tags.

2.3 BASIC PIPE, TUBE AND FITTINGS

- A. Provide pipe, tube and fittings complying with Section 220010 Basic Materials and Methods - Plumbing and in accordance with the following listing:

1. Interior Piping: Schedule 40 black steel ASTM A-53, A-106

Fittings: Malleable black iron, threaded (for low pressure gas)

Fittings: Wrought steel, butt welded (for elevated pressure gas)

2. Exterior Below Grade Piping: Medium-density polyethylene pipe and fittings.

3. Exterior Exposed or Roof Top Piping: Schedule 40 black steel with weather coating.

Fittings: Wrought steel, butt welded (for pipe 2-1/2" larger)

Fittings: Malleable black iron, threaded (for pipe 2" and less)

4. Viega mega press:

Press connection that meets the standards of the IFGC (for pipe 1/2" to 4").

2.4 BASIC PIPING SPECIALTIES

- A. Provide piping specialties complying with applicable Division 22 Sections and in accordance with the following listing:

Pipe escutcheons

Pipe sleeves

Sleeve seals

2.5 SPECIAL VALVES

- A. Valves required for gas piping systems on this project shall be the following types:

Gas Valves: (Up to 3")

1. Apollo 80-100 Series bronze gas ball valve. Threaded, 600 PSIG WOG, cold non-shock. 250 PSIG LP-Gas. 150 PSIG saturated steam. Vacuum service to 29 inches Hg. Federal Specification: WW-V-35C, Type: II, Composition: BZ, Style: 3.

2. Features:

- UL Listed for LP-Gas and natural gas.

- Large ports to reduce pressure drop

- Reinforced TFE seats and seals

- Blow-out-proof stem design

- Optional tee handle available

- Quarter turn on-off

- Adjustable packing gland

- One piece bronze body

- Chromium plated ball

3. UL Listings:

- Guide YRPV: Gas shut-off valve for use with natural and manufactured gases.

4. This valve shall be used for all pipe sizes up to 3" in the system.

Gas Valves (4" and Larger)

1. Apollo 88A-100 Series carbon steel, ANSI Class 150 flanged standard port ball valves.

Standards of Compliance:

IFGC: Section 409 (Valves)

ASME B16.5 – Pipe Fittings and Flanges

ASME B16.33 – Manual Operated Metal Gas Valves up to 125 psig

ASME B16.38 – Large Metal Valve Gas Distribution

ASME B31.8 – Gas Transmission and Distribution Piping Systems

UL 125

- B. Manufacturers: Subject to compliance with requirements, provide gas valves of one of the following:
Apollo/Conbraco
Stockham
Milwaukee
NIBCO, Inc.
Watts

2.6 GAS METER

- A. Provided by Chesapeake Gas Division.

2.7 GAS PRESSURE REGULATORS

- A. ANSI Z21.18, single-stage, steel-jacketed, corrosion-resistant pressure regulators. Include atmospheric vent, elevation compensator, with threaded ends conforming to ASME B1.20.1 for 2 inch NPS and smaller and flanged ends for 2-1/2" NPS and larger. Regulator pressure ratings, inlet and outlet pressures, and flow volume in cubic feet per hour of natural gas at specific gravity are as indicated.
 1. Service Pressure Regulators: Inlet pressure rating not less than natural gas distribution system service pressure.
 2. Line Gas Pressure Regulators: Inlet pressure rating not less than system pressure.
 3. Appliance Gas Pressure Regulators: Inlet pressure rating not less than system pressure.
 4. Gas Pressure Regulator Vents: Factory or field installed corrosion-resistant screen in opening when not connected to vent piping.
 5. Regulators shall be as noted in schedule.

B. AVAILABLE MANUFACTURES

1. Subject to compliance with the requirements, manufacturer of gas equipment products other than as identified on the Schedule but is selected from the available manufacturers listed above, a cover sheet shall be included with the submission of shop drawings indicating the cross-referenced manufacturer and model number.
2. Shop drawings shall not be reviewed or accepted if not in compliance with this requirement.
Fisher
Sensus
Emerson

PART 3 – EXECUTION

3.1 INSTALLATION OF BASIC IDENTIFICATION

- A. Install mechanical identification in accordance with applicable Division 22 Sections.

3.2 INSTALLATION OF NATURAL GAS PIPING (INTERIOR)

- A. Install natural gas distribution piping in accordance with Section 220010 Basic Materials and Methods - Plumbing and in accordance with applicable codes IFGC latest edition, and local Utility Company requirements.
- B. Use sealants on metal gas piping threads which are chemically resistant to natural gas. Use sealants sparingly, and apply to only male threads of metal joints.
- C. Remove cutting and threading burrs before assembling piping.
- D. Do not install defective piping or fittings. Do not use pipe with threads which are chipped, stripped or damaged.
- E. Plug each gas outlet, including valves, with threaded plug or cap immediately after installation and retain until continuing piping or equipment connections are completed.
- F. Install drip-legs in gas piping where indicated, and where required by code or regulation.
- G. Install "Tee" fitting with bottom outlet plugged or capped at bottom of pipe risers.
- H. Use dielectric unions where dissimilar metals are joined together.
- I. Install piping with 1" drop in 60' pipe run (0.14%) in direction of flow.
- J. Install piping parallel to other piping, but maintain minimum of 12" clearance between gas piping and steam or hot water piping above 200 degrees F (93 degrees C).
- K. For piping buried in building substrate, or below floor slabs, install in welded conduit, ventilated to outdoors on both ends, and tested to same requirements as gas piping.
- L. Gas valves shall not be installed above ceilings without access and signage.
- M. Supports:
 - 1. All pipe, fittings, valves, installation and testing shall be in accordance with the IFGC, Chapter 4.
 - 2. Gas piping shall be supported in accordance with the International Fuel Gas Code's latest accepted 2003 Edition, Section 407, as follows:
 - 3. Support intervals shall be in accordance with the IFGC listed above and in Section 415, Table 415.1 as follows:
 - a. Steel pipe ½" nominal size – not to exceed 6 ft.
 - b. Steel pipe ¾" to 1" nominal size – not to exceed 8 ft.
 - c. Steel pipe 1-1/4" and larger nominal size horizontal – not to exceed 10 ft.
 - d. Steel pipe 1-1/4" and larger nominal size, vertical not to exceed every floor.
 - 4. Support and spacing of CSST Systems shall be in accordance with CSST manufacturer's instructions.
 - 5. All hangers, anchors, support and guides for piping, and equipment shall be securely fastened to the building structure and/or floors with concrete decking with the following exception. Hangers, anchors, support and guides shall not be fastened to or through metal roof decking (i.e. bare metal decking or metal deck supporting a roofing system).

3.3 GAS SERVICE

- A. Arrange and coordinate with Utility Company to provide gas service and meter at indicated location with shutoff at terminus. Consult with Utility as to extent of its work, costs, fees and permits involved. Pay such costs and fees; obtain permits.
- B. Extend service pipe from Utility's terminus to distribution piping, in compliance with Utility's requirements.

3.4 INSTALLATION OF VALVES

- A. Gas valves: Provide at connection to gas train for each gas-fired equipment item; and on risers and branches where indicated.
- B. Locate gas valves where easily accessible, and where protected from possible damage.

3.5 EQUIPMENT CONNECTIONS

- A. Connect gas piping to each gas-fired equipment item, with drip leg, union and shutoff gas valve. Comply with equipment manufacturer's instructions. Drip legs shall not be installed on any exterior gas piping.
- B. Equipment furnished by the Owner, or Contractors other than this Contractor: After equipment has been set in place, this Contractor shall furnish all labor and material required to make final connections between roughing-in and the equipment. Install valves, fittings, trim and appurtenances furnished with the equipment. Piping shall be of the same material as the system to which it connects.
- C. All rooftop, gas-fired equipment shall be provided with gas pressure regulating valve to reduce gas pressure from 2 psi to 14.7" WC. All regulators shall be provided with relief vent discharge piping of lengths as required for minimum distance of equipment air intake grilles.

3.6 INSTALLATION OF GAS PRESSURE REGULATORS

- A. This Contractor shall furnish and install gas pressure regulating valves for all shown on the drawings. Installation shall be in strict accordance with the requirements of the Utility Company and the Canadian Gas Association.
- B. All regulators installed shall be tagged with data noting the inlet and outlet pressure for each individual regulator installed.
- C. Medium or High Pressure (MP) (HP) Regulators shall comply with the following:
 - 1. The MP regulator shall be approved and shall be suitable for the inlet and outlet gas pressures for the application.
 - 2. The MP regulator shall maintain a reduced outlet pressure under lockup (no flow) conditions.
 - 3. The capacity of the MP regulator, determined by published ratings of its manufacturer, shall be adequate to supply the appliances served.
 - 4. The MP pressure regulator shall be provided with access. Where located indoors, the regulator shall be vented to the outdoors or shall be equipped with a leak-limiting device, in either case complying with Section 410 of the IFGC.
 - 5. A tee fitting with one opening capped or plugged shall be installed between the MP regulator and its upstream shutoff valve. Such tee fitting shall be positioned to allow connection of a pressure-measuring instrument and to serve as a sediment trap.
 - 6. A tee fitting with one opening capped or plugged shall be installed not less than 10 pipe diameters downstream of the MP regulator outlet. Such tee fitting shall be positioned to allow connection of a pressure-measuring instrument.

3.7 EXTERIOR GAS PIPING

- A. All rooftop or exterior gas piping shall be weatherproof with and epoxy resin approved by the Gas Company.
- B. Uncoated, threaded or socket welded joints shall not be used in piping in contact with soil or where internal or external service corrosion is known to occur.
- C. Protective Coatings and Wrapping: Pipe protective coatings and wrappings shall be approved for the application and shall be factory applied.
- D. Detectable underground warning tape shall read (“CAUTION – BURIED GAS LINE BELOW”). Printed on APWA approved colors, minimum 2” wide, 5 mil tape with aluminum backing for using non-ferrous locator.

END OF SECTION

SECTION 22 01 40 FIXTURES - PLUMBING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the Work specified in this Section.

1.2 DESCRIPTION OF WORK

- A. This Section includes:
 - 1. Plumbing fixtures and trim work as indicated by drawings and schedules, and by requirements of this section.
 - 2. Types of plumbing fixtures required for the project include the following:
 - Water Closets
 - Urinals
 - Lavatories
 - Countertop Sinks
 - Service Sinks
 - Mop Receptors
 - Showers
 - Electric Water Coolers
 - Manually Operated Flush Valves and Faucets
 - Handicap Lavatory Insulation
 - Lavatory Shield Enclosure
 - 3. Refer to Section 220120 for domestic water piping systems used in conjunction with plumbing fixtures; not work of this section.
 - 4. Refer to Section 220110 for soil and waste piping systems used in conjunction with plumbing fixtures; not work of this section.
 - 5. Refer to Division 26 sections for electrical connections to water coolers and other plumbing fixtures; not work of this section.

1.3 REFERENCE STANDARDS

- A. Refer to Section 220000 for a general description of requirements applying to this section.

1.4 QUALITY ASSURANCE

- A. Refer to Section 220010 for a general description of requirements applying to this section.
- B. Manufacturers: Firms regularly engaged in manufacture of plumbing fixtures of the type, style and configuration required, whose products have been in satisfactory use in similar service for not less than 3 years.
- C. Plumbing Fixture Standards: Comply with applicable portions of International Plumbing Code pertaining to materials and installation of plumbing fixtures.
- D. ANSI Standards: Comply with applicable ANSI standards pertaining to plumbing fixtures and systems.

- E. ANSI & ADA Standards: Comply with ANSI A171.1 Standard and the ADA Standard pertaining to plumbing fixtures and provisions for handicapped.
 - 1. Water closets shall measure 17" to 19" from the floor to the top of the seat. Bowls shall be elongated type.
 - 2. Flush valve mechanisms shall be on the wide side of the stall, no higher than 44" above the floor.
 - 3. Urinals shall be elongated (14" rim from the wall) mounted no higher than 17" from the floor.
 - 4. Lavatories shall be mounted no higher than 34" from the floor and provide knee clearance using an offset drain assembly with "P" trap set parallel to the fixture supporting wall. Trap and wall supplies shall be installed for clearance required for the installation of lavatory shield enclosures.
 - 5. Faucets shall be lever operated, push type, touch type, electronically operated. See Fixture Schedule. All faucets shall operate on less than 5 pounds force and shall not require tight grasping, pinching or twisting of the wrist.
 - F. PDI Compliance: Comply with standards established by Plumbing and Drainage Institute pertaining to plumbing fixture supports.
 - G. Federal Standards: Comply with applicable FS WW-P-541/- Series sections pertaining to plumbing fixtures.
 - H. UL Labels: Provide water coolers which have been listed and labeled by Underwriters' Laboratories.
 - I. ARI Labels: Provide water coolers which are rated and certified in accordance with applicable Air-Conditioning and Refrigeration Institute Standards.
- 1.5 SUBMITTALS
- A. Submit shop drawings and product data in accordance with Section 220000.
 - B. Submit the following:
 - 1. Product Data: Submit manufacturer's specifications for plumbing fixtures and trim, including catalog cut of each fixture type and trim item furnished, roughing-in dimensioned drawings, templates for cutting substrates, fixture carriers, and installation instructions.
 - 2. Color Selection Data: Submit charts or samples for color selection where applicable.
 - 3. Maintenance Data: Submit maintenance data and parts lists for each fixture type and trim item, including instructions for care of finishes. Include this data in maintenance manual.
- 1.6 WARRANTY/GUARANTEE
- A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, GENERAL REQUIREMENTS.
- 1.7 PRODUCT DELIVERY, STORAGE AND HANDLING
- A. Deliver plumbing fixtures individually wrapped in factory-fabricated containers.
 - B. Handle plumbing fixtures carefully to prevent breakage, chipping and scoring the fixture finish. Do not install damaged plumbing fixtures; replace and return damaged units to equipment manufacturer.

PART 2 – PRODUCTS

2.1 PLUMBING FIXTURES

- A. Provide factory-fabricated fixtures of type, style and material indicated. For each type fixture, provide fixture manufacturer's standard trim, carrier, seats, and valves as indicated by their published product information; either as designed and constructed, or as recommended by the manufacturer and as required for a complete installation. Where more than one type is indicated, selection is Installer's option; but, all fixtures of same type must be furnished by single manufacturer. Where type is not otherwise indicated, provide fixtures complying with governing regulations.

2.2 MATERIALS

- A. Unless otherwise specified, comply with applicable Federal Specification WW-P-541/-Series sections pertaining to plumbing fixtures, fittings, trim, metals and finishes. Comply with the requirements of WW-P-541/-specification relative to quality of ware, glazing, enamel, composition and finish of metals, air gaps, and vacuum breakers, even though some plumbing fixtures specified in this section are not described in WW-P-541/-.
- B. Provide materials which have been selected for their surface flatness and smoothness. Exposed surfaces which exhibit pitting, seam marks, roller marks, foundry sand holes, stains, decoloration, or other surface imperfections on finished units are not acceptable.
- C. Where fittings, trim and accessories are exposed or semi-exposed, provide bright chrome-plated or polished stainless-steel units. Provide copper or brass where not exposed.
- D. Stainless Steel Sheets: ANSI/ASTM A-167, Type 302/304, hardest workable temper. Finish: No. 4, bright, directional polish on exposed surfaces.
- E. Steel Sheets for Baked Enamel Finish: ANSI/ASTM A-591, coating Class C, galvanized-bonderized.
- F. Steel Sheets for Porcelain Enamel Finish: ANSI/ASTM A-424, commercial quality, Type 1.
- G. Vitreous China: High quality, free from fire cracks, spots, blisters, pinholes, and specks; glaze exposed surfaces, and test for crazing resistance in accordance with ANSI/ASTM C-554.
- H. Fiberglass: ANSI Z124 smooth surfaced, with color selected by Architect/Engineer.
- I. Aluminum: ANSI/ASTM B-209/B-221 sheet, plate and extrusions, as indicated; alloy, temper and finish as determined by manufacturer, except 0.40 mil natural anodized finish on exposed work unless another finish is indicated.
- J. Synthetic Stone: High quality free from defects, glaze on exposed surfaces, stain resistant.

2.3 PLUMBING FITTINGS, TRIM AND ACCESSORIES

- A. Lavatory Protective Shield Covers:
 - 1. Fully molded enclosure "Lav Shields" as manufactured by Zurn or Truebro, Inc., complete with tamper-resistant stainless steel fasteners.
 - 2. Shield enclosure to meet A.D.A. #4.19.4, ANSI A117.1 and BOCA P- 1203.4.
- B. Water Outlets: At locations where water is supplied (by manual, automatic or remote control), provide commercial quality faucets, valves, or dispensing devices, of type and size indicated, and as required to operate as indicated. Include manual shutoff valves and connecting system pipes to permit outlet servicing without shut- down of water supply piping systems.
 - 1. Vacuum Breakers: Provide with flush valves where required by governing regulations, including locations where water outlets are equipped for hose attachment.
- C. P-traps: Include removable P-traps where drains are indicated for direct connection to drainage system. All traps shall be minimum 17 gauge.
- D. Carriers: Provide cast-iron and/or steel supports for fixtures. Carriers shall be provided for all wall-hung fixtures, and/or the carrier shall be selected to support the fixture independently of the wall. Carriers shall be adjustable type, complete with all fittings and foot supports. Carrier shall be single or double, back-to-back, horizontal offset and vertical stack type. Carrier shall be selected and used as best suited within the pipe chases. Where noted or indicated, stud mount type carriers shall be used and installed within stud wall s 8" and less.
- E. Fixture Bolt Caps: Provide manufacturer's standard exposed fixture bolt caps finished to match fixture finish.

- F. Escutcheons: Where fixture supplies and drains penetrate walls in exposed locations, provide chrome plated sheet steel escutcheons with friction clips.
- G. Aerators: Provide aerators of types approved by Health Departments having jurisdiction.
- H. Comply with additional fixture requirements contained in fixture schedule attached to this section.

2.4 FIXTURE LIST

- A. Refer to the "Plumbing Fixture & Equipment Schedule" as indicated on the drawings.

2.5 SHOWER - HANDICAP

- A. The shower modules shall be manufactured by Crane Plumbing/Fiat Products #MSCI-307, RH/LH (36" x 35") and shall be thermoformed from continuous cast acrylic sheet into one piece, seamless units. The units shall be reinforced in the back with fiberglass reinforced polyester resin and have a backside fire rating of "A" and flame spread of 25.
- B. Shower modules shall be pre-drilled and equipped with a model 180AA pressure balanced, single dial lever mixing valve with stops, hand held shower head with swivel fitting, 69" flexible stainless steel hose and in-line vacuum breaker, 10 oz. GSA approved shower curtain with curtain hoods, 2" cast brass chrome plated shower drain, and 1" diameter stainless steel curtain rod.
- C. All units shall have anti-skid floor treatment to meet performance requirements of ASTM F-462-78. All units are listed under SBCCI Report No. 8556 and BOCA Report No. 86-40.
- D. Additional back reinforcements shall be suitably located to provide code complying structural integrity for factory attaching of grab bars, curtain rod, and slide guide for hand held flexible hose shower head.
- E. Standard Equipment:
 - 1. Factory Installed:
 - a. Grab Bars: see table for individual models.
 - b. Curtain rod: 1" diameter, stainless steel.
 - c. Shower curtain, 10 oz. with curtain hooks, GSA approved.
 - d. 2" shower drain, chrome plated, cast brass.
 - e. Retractable, compact shower seat with stainless steel frame and teakwood seat.
 - 2. Optional Equipment:
 - a. Model 180AA pressure balanced, single dial lever mixing valve with integral check stops.
 - b. Hand held shower H-11 with swivel fitting, 69" flexible stainless steel hose, and in-line vacuum breaker.
 - c. Slide guide H-12, 24"
 - d. Dome light, ATP-1, 60 watt, recessed.
- F. Color: Color option is required. Final selection by Architect.

2.6 FLUSH VALVES & FAUCETS

- A. This Contractor shall furnish and install complete and operating metered and manual faucets and manual flush valves where so indicated and noted on the drawings and schedule.
- B. The Contractor shall install the system in strict conformance with the manufacturer's written instructions. The installation shall be executed with good workmanship and to be clear of any interference with the user including the installation of lavatory protective shield enclosures.
- C. All faucet installations shall require a mixing valve for single water supply to handwashing faucet.

2.7 AVAILABLE MANUFACTURERS

- A. Subject to compliance with requirements, manufacturers offering fixtures, trim and carriers which may be incorporated in the work include, and are limited to the following:

Water Closets (Wall-Mounted Back Outlet – China)

Zurn

American Standard

Kohler

China/ENAMELED Fixtures

Zurn

Kohler

American Standard

Faucets/Trim (Non-Sensor Operated)

Zurn

Kohler

American Standard

Delta

Moen

Elkay

Speakman

Chicago

Flush Valves

Sloan “Royal”

Coyne & Delany

Zurn

ToTo

Delta

Wall Supplies/Traps

McGuire

Brass-Craft

Kohler

American Standard

Sanitary-Dash

Teledyne

Wolverine

Pro-Flo

Keeny

Mainline

Fixture Carriers

Zurn

Josam

Wade

Watts

Smith

MIFAB

Fixture Seats

Olsonite

Sperzel

Benke

Bemis

Church

Kohler

American Standard

Centoco

Comfort Seat

Mop Receptors

Fiat

Stern-Williams

Mustee

Florestone

Water Coolers

Elkay

Haws

Halsey-Taylor

Oasis

Acorn

Stainless Steel Sinks

Elkay

Just

Dayton

Advanced-Tabco

Shower Assemblies & Systems

Acorn

Symmons

Leonard

Powers

Bradley

Moen

Note: All mop receptor installations must include the combination eyewash and service sink faucet arrangement.

Emergency/Safety Equipment

Bradley

Haws

Western

Speakman

Guardian

Shower Units

Fiat

Fibersheen

Kohler

American Standard

Acryline

Aqua-Glass

Aquarius

Aqua-Bath

Washer Utility Boxes

PPP, Inc.

Symmons

Guy-Gray

Oatey

B. Cross Reference Identification:

1. If the Contractor selects a manufacturer of drainage equipment products other than as identified on the Schedule but is selected from the available manufacturers listed above, a cover sheet shall be included with the submission of shop drawings indicating the cross referenced manufacturer and model number.
2. Shop drawings shall not be reviewed or accepted if not in compliance with this requirement.

2.8 HANDICAP LAVATORY INSULATION

- A. Fully molded "P" trap and angle valve insulation kit Handi-Lav Guard Truebro Model #101, 102 and 105 to suit.
- B. Insulation to meet A.D.A. #4.19.4, ANSI A117.1 and BOCA P- 1203.4.
- C. Self-extinguishing ASTM D635 burn characteristics, Thermal conductivity ASTM C177-K value 1.17.

PART 3 – EXECUTION

3.1 FIXTURE CONNECTIONS

- A. Connections to plumbing fixtures shall be of the sizes indicated on the "Plumbing Fixture & Equipment Schedule".
- B. The sizes indicated on the Schedule are for drainage and water piping serving an individual fixture; the sizes of the mains and branches shall be as indicated on the drawings.

3.2 FIXTURE SETTING HEIGHTS

- A. The plumbing fixtures shall be set in accordance with the heights established by the latest edition of codes and ADA requirements.

Note: Height indicated is established as follows:

Water Closets:	From finished floor to top of seat.
Urinals:	From finished floor to rim of fixture.
Lavatories & EWC:	From finished floor to rim of fixture.
Receptor Fitting:	From finished floor to center of fitting.
Shower:	From finished floor to center of shower head.

- B. Refer to Architectural drawings and sections for fixture elevations. Fixtures in various areas may be set at lower elevations. Confirm all rough-in elevations prior to any installation.

3.3 LAVATORY PROTECTIVE SHIELD ENCLOSURES

- A. Installation shall conform to manufacturer's written instructions.
- B. All items involved with wall-hung lavatory installations shall be roughed-in and installed within the enclosure. This includes the offset "P" trap assembly, thermostatic mixing valve, sensor faucet trim and accessories, electrical outlet. Coordinate all work required for complete concealment of all devices.

3.4 INSPECTION AND PREPARATION

- A. Examine roughing-in work of domestic water and waste piping systems to verify actual locations of piping connections prior to installing fixtures. Also examine floors and substrates, and conditions under which fixture work is to be accomplished. Correct any incorrect locations of piping, and other unsatisfactory conditions for installation of plumbing fixtures. Do not proceed with work until satisfactory conditions have been corrected.
- B. Install plumbing fixtures of types indicated where shown and at indicated heights; in accordance with fixture manufacturer's written instructions, roughing-in drawings, and with recognized industry practices. Ensure that plumbing fixtures comply with requirements and service intended purposes. Comply with applicable requirements of the International Plumbing Code pertaining to installation of plumbing fixtures.
- C. Fasten plumbing fixtures securely to indicated supports or building structure; and ensure that fixtures are level and plumb. Secure plumbing supplies behind or within wall construction so as to be rigid, and not subject to pull or push movement.

3.5 CLEAN AND PROTECT

- A. Fixture shall be thoroughly cleaned after completion of installation.
- B. Protect installed fixtures from damage during the remainder of the construction period.

3.6 FIELD QUALITY CONTROL

- A. Upon completion of installation of plumbing fixtures and after units are water pressurized, test fixtures to demonstrate capability and compliance with requirements. When possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units and proceed with retesting.
- B. Inspect each installed unit for damage to finish. If feasible, restore and match finish to original at site; otherwise, remove fixture and replace with new unit. Feasibility and match to be judged by Architect/Engineer. Remove cracked or dented units and replace with new units.

END OF SECTION

SECTION 22 01 50
EQUIPMENT - PLUMBING**PART 1 – GENERAL****1.1 RELATED DOCUMENTS**

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the Work specified in this Section.

1.2 DESCRIPTION OF WORK

- A. This section includes:
 - 1. Plumbing equipment as indicated on drawings and provisions of this section, including schedules and equipment lists associated with either drawings or this section.
 - 2. Types of plumbing equipment required for project include the following:
 - Recirculating Pumps-Domestic Water Return (110 degrees & 140 degrees)
 - Exterior Grease Interceptor Vault
 - Solids Interceptor
 - Domestic Water Heater
 - Thermostatic Mixing Valve
 - Elevator Sump Pump System

1.3 REFERENCE STANDARDS

- A. Refer to Section 220000 for a general description of requirements applying to this section.
- B. UL and NEMA Compliance: Provide electric motors and electrical components required as part of plumbing equipment, which have been listed and labeled by Underwriters' Laboratories and comply with NEMA Standards.
- C. NEC Compliance: Comply with National Electrical Code (ANSI/NFPA 70) as applicable to installation and electrical connections of ancillary electrical components of plumbing equipment.
- D. ASME Relief Valve Stamps: Provide water heaters with safety relief valves bearing ASME valve markings.
- E. AWWA Compliance: Comply with applicable American Water Works Association Standards pertaining to steel water tanks.
- F. CSA and NSF Labels: Provide water tanks which have been listed and labeled by CSA International and National Sanitation Foundation.
- G. ASME Code Symbol Stamps: For the following equipment, comply with ASME Boiler & Pressure Vessel Code for construction and stamp with ASME Code Symbol:
 - Domestic Water Heater
- H. All packaged equipment shall be independently third party, labeled as a system for its intended use by a nationally recognized testing laboratory (NRTL) in accordance with OSHA Federal Regulations 29CFR 1910.303 and .349 as well as NFPA Pamphlet #70 and NEC Article 90.7.

1.4 QUALITY ASSURANCE

- A. Refer to Section 220010 for a general description of requirements applying to this section.

1.5 SUBMITTALS

- A. Submit shop drawings and product data in accordance with Section 220000.

- B. Submit the following:
 - 1. Product data on all equipment including roughing-in data.
 - 2. Connection diagrams for related piping and specialties.

1.6 WARRANTY/GUARANTEE

- A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, GENERAL REQUIREMENTS

PART 2 – PRODUCTS

2.1 EQUIPMENT

- A. Refer to "Plumbing Fixture & Equipment Schedule" for type, numbers, size and manufacturer of all equipment accessories.

2.2 HOT WATER CIRCULATING PUMPS

- A. Provide and install where indicated on the drawings, domestic hot water circulating pumps complete with controls and piping as shown on the drawings. Each pump shall have a capacity, as noted on the drawings and schedule.
- B. Pumps shall be close coupled, centrifugal type, all low lead- or lead-free bronze with flexible connection to single phase motor.
- C. Pump shall be controlled by a manual starter, furnished and installed by the Electrical Contractor. Pumps shall run continuously and be wired into night setback operations.

2.3 MASTER MIXING VALVE

- A. Mixing valve shall be constructed entirely of lead free bronze and copper and hydrostatically tested to a pressure of 300 lb. Unit shall be provided with the following features.
 - 1. A long mixing chamber with vanes at an angle to the longitudinal axis of the valve which shall cause a thorough mixing of the hot and cold water.
 - 2. The length of the hydraulic thermostatic element shall assure effective contact with the water.
 - 3. The thermostatic element shall be placed in the body of the valve where the hot and cold water mix. Unit shall be sensitive to any change in water temperature and make the proper correction by opening or closing the hot and cold water inlets in the valve.
 - 4. The sensitive parts of the thermostatic element shall be inside a heavy non-ferrous tube which shall protect them from any corrosive or scaling action caused by the continuous flow of water past them.
- B. Unit shall be as sized on the drawings.
- C. Temperature adjusting range shall be between 80 and 160 degrees F.

2.4 WATER HEATER

- A. The water heater shall be Bradford White Model, as noted on the drawings and schedule, with a storage capacity as noted on the drawings and schedule, input as noted on drawings and schedule, and a minimum recovery as noted on the drawings and schedule. It shall be design certified by the CSA International Z21.10.3 for 180 deg. F application. The tank shall be lined with Vitraglas vitreous enamel. The tank shall have one extruded magnesium anode rod. The insulation shall be foam material of 1" nominal thickness. The entire installation shall be made in accordance with state and local codes and ordinances.
- B. Vacuum Relief Valve: All bottom fed water heaters and bottom fed hot water storage tanks connected to water heaters shall be installed with a vacuum relief valve. The valve shall be installed on the (cold water) fed piping above the top of the water heater and/or storage tank and per the manufacturer's requirements. Vacuum relief valves shall comply with ANSI Z21.22.

2.5 EXTERIOR GREASE INTERCEPTOR

- A. Interceptor shall be constructed of precast, reinforced concrete in accordance with the Local Plumbing Code requirements. Interceptor shall include inlet, outlet and vent piping, baffles and manhole frames and covers. All piping shall be PVC soil pipe and fittings, and manhole frames and covers shall be rated for heavy duty.

2.6 SOLIDS INTERCEPTOR

- A. Solids interceptor shall be cast iron, porcelain enameled inside and outside with lumaloy sediment bucket and removable bronze screens and lumaloy gasketed cover with locking device.

2.7 MANUFACTURERS

- A. Subject to compliance with requirements, manufacturers offering plumbing equipment shall be limited to the following:

1. Domestic Water Heaters

Ruud

Bradford-White

State

2. Hot Water Circulating Pumps

Armstrong

Bell and Gossett

Taco

Aurora

Grundfos

Amtrol

3. Solids Interceptors

Zurn

Josam

Wade

Ancon

Smith

4. Exterior Interceptor Vaults (Precast)

Tyson F. Sartin

A.C. Miller

Penn Cast

5. Master Mixing Valve (Domestic Hot Water System)

Holby Valve Co.

Acorn

2.8 ELEVATOR SUMP PUMP (COMPLIES W/DE STATE ELEVATOR CODE)

- A. Provide pump and control systems capable of pumping water while containing oil. The system shall function automatically and shall provide for an alarm and separate LED lights in the event of (a) the presence of oil in the sump, (b) high liquid in the sump, or (c) high amps or a locked rotor condition. In addition, LED lights shall be provided for (1) power and (2) pump run function. An alarm that

sounds only in the event of a high liquid condition or does not separately identify the above five functions shall not be acceptable.

- B. The pump shall be a submersible type, capable of pumping up to 37' TDH and 74 GPM. The pump shall be approved to UL 778 standards and shall include thermal and overload protection. The motor shall be rated 1/2 H.P., 1 phase, 115V and capable of operating continuously or intermittently. The motor housing shall be constructed of #304 stainless steel and mechanical seats shall be housed in a separate oil-filled compartment.
- C. The main control shall be approved to UL 508 standards and housed in a gasketed NEMA 4X enclosure with a see-through window for observation of operating functions. The control unit, junction box, pump, floats and sensor shall be factory assembled as a complete, ready-to-use system and shall be tested and approved as a complete system by a nationally recognized testing laboratory such as ENTELA. The control panel shall be equipped with dual solid state Oil-Minder relays with variable sensitivity settings, an over current relay, self-cleaning stainless steel sensor probe, high decibel warning horn with alarm silencing switch, dual floats, clearly marked cable terminal board and remote monitoring contact. A NEMA 4X (sump pit) junction box with rigid conduit shall be provided. (Note: The control panel and the NEMA 4X (sump pit) junction box shall not be provided with 8-pin twist lock receptacles. All pump power and control cables between the control panel and NEMA 4x junction box shall be by the E.C. and shall have their length determined in the field. The cables between the control panel and junction box shall be connected directly to the equipment terminal boards and shall be run in ridge, galvanized conduit.) See installation detail on Plumbing Drawings. All cables between the pump and junction box shall be 16 ft. long and the power cable and plug from the control panel shall be 6 ft. long. The system shall allow for the main control to be located outside of the elevator hoistway and monitoring of all functions without having to enter the elevator shaft.

PART 3 – EXECUTION

3.1 INSTALLATION OF WATER HEATERS

- A. Install water heaters where indicated in accordance with manufacturer's installation instructions and in compliance with applicable codes.
- B. Set units where indicated, orient so controls and devices needing service and maintenance have adequate access. Level and plumb units. Each unit shall be set on a concrete housekeeping pad.
- C. Existing Mechanical Room: Reconnect existing gas hot and cold piping to new unit. Alter piping to suit new connections. Connect recirculating line to unit with check valve and shutoff valve. Extend relief valve discharge to nearest floor drain. Extend and connect new flue exhaust to existing breeching.
- D. New Mechanical Room: Connect gas, hot and cold and recirculating piping system and all associated equipment and devices as detailed on the drawing. Flue extension, roof penetration and weatherproof hood shall be by this Contractor.
- E. Start-up, test and adjust hot water heaters in accordance with manufacturer's start-up instructions. Check and calibrate controls.

3.2 INSTALLATION OF THERMOSTATIC MIXING VALVE

- A. Install mixing valve in accordance with manufacturer's installation instructions and in compliance with applicable codes.
- B. At startup of domestic hot water system, mixing valve outlet temperature shall be checked to insure proper setting and operation. Following adjustments, if required, the mixing valve, if not performing, check if factory required differential temperature in/out with a minimum of 20° Delta "T" is maintained.

- C. The temperature of the water delivered by the mixing valve shall be changed by turning the adjusting screw to the right or clockwise for lower temperature; and to the left or counter clockwise for higher temperatures. Maintain a uniform temperature regardless of temperature of incoming water. To facilitate adjustment, a thermometer shall be placed in the line beyond the Holby Tempering Valve as shown in the diagram and water shall be flowing through the Holby Tempering Valve while adjustment is being made.
- D. Check valves shall be installed on both inlet (hot and cold) to the unit. Include a full size bypass valve arrangement.
- E. The hot water return line shall always be piped through the cold water make-up side of the mixing valve.

3.3 INSTALLATION OF HOT WATER CIRCULATING PUMPS

- A. Install pumps where indicated, in accordance with manufacturer's published installation instructions, with recommended clearances provided for service and maintenance.
- B. Install in-line pumps, supported from piping system, located for access to oil cups, service, and maintenance.
- C. Lubricate pumps before start-up. Start-up shall be in accordance with manufacturer's instructions.
- D. Install pump unit as detailed on the drawing. Include a check valve and thermometer at the pump unit. The pump shall run on continuous operation. The pump shall be wired into night setback by the ATC system installer.

3.4 INSTALLATION OF EXTERIOR GREASE INTERCEPTOR

- A. Install precast interceptor in accordance with manufacturer's installation instructions and in compliance with applicable codes.
- B. Interceptor shall be set level on a base bed of crushed stone. Inlet, outlet and piping shall be adjusted, as required, to insure proper elevations with respect to inlet and outlet.
- C. Provide all excavation and backfill as required to install the unit.
- D. Install increment rings or extensions for access to finished grade. Install and set manhole frames and covers true and level flush with finished grade.
- E. Install vent piping and extend up through building to 18" above roof level. The vents shall be a minimum of 4" in size and shall be connected to the vault chamber and also in the drain line prior to the inlet connection. No other system vents shall connect to the grease interceptor vent system.

3.5 INSTALLATION OF ELEVATOR SUMP PUMP SYSTEM

- A. Furnish and install all system equipment for a complete and operating installation. The equipment shall be installed as detailed on the drawing and in accordance with manufacturer's and equipment supplier's written instructions.
- B. The pump and switch shall be installed within the elevator pit sump cavity. Install gate valve and check valve in pump discharge. Provide a cover grate atop the sump pit opening.
- C. The installation shall include a high water alarm system and panel. Install floats within the sump pit. The alarm panel shall be a remote installation in the Elevator Machine Room where indicated on the drawing.
- D. Electrical power wiring shall be provided to the panel by the Electrical Contractor, including control wiring and conduit to junction box in the sump pit. All wiring beyond that point shall be considered control wiring and shall be the responsibility of the pump installation contractor. Coordinate with the Electrical Contractor for all electrical connections required. All work responsibilities shall be verified and executed for a complete operating and functional installation. Refer to drawing detail/diagram.

- E. The Electrical Contractor shall provide a dedicated receptacle at the pump unit for system operation.
- F. All pump equipment, piping, etc., shall be kept clear of all elevator cab operations and shall meet the approval of the elevator inspector.

END OF SECTION

SECTION 22 01 90 TESTING - PLUMBING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary and other conditions, if any) and Division 1 as appropriate, apply to the work specified in this Section.

1.2 DESCRIPTION OF WORK

- A. Extent of plumbing systems to be tested is indicated on the drawings and by requirements of this section.
- B. Applications of tests include the following:
 - 1. Interior Piping
 - a. Domestic cold, hot & hot water return piping
 - b. Gas piping
 - c. Sanitary and condensate waste drainage piping
 - d. Storm water drainage piping
 - 2. Exterior Piping
 - a. Sanitary drainage piping
 - b. Domestic water service
 - c. Gas service
 - d. Storm drainage piping
- D. See Fire Protection Specifications for testing of Fire Protection Systems.

1.3 REFERENCE STANDARDS

- A. Refer to Section 220000 for a general description of requirements applying to this section.

1.4 QUALITY ASSURANCE

- A. Refer to Section 220010 for a general description of requirements applying to this section.

1.5 SUBMITTALS

- A. Submit test reports in accordance with Section 220000.

1.6 WARRANTY/GUARANTEE

- A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, GENERAL REQUIREMENTS.

PART 2 – PRODUCTS

2.1 PIPE & FITTING REPLACEMENTS

- A. Refer to Section 220010 for replacement of any defective pipe or fittings. Replacement shall include all required uncovering, excavating, recovering and backfilling.

PART 3 – EXECUTION

3.1 GENERAL

- A. All exterior or interior piping shall be tested and approved before backfilling or concealing. Failure to secure the approval of the Municipal Inspector, Utility Company's Inspector or the Inspector of the Architect/Engineer makes it mandatory for the Contractor to completely expose the piping for testing.

All expense involved in the uncovering of the piping for the test and recovering shall be borne by the respective Contractor with no change in Contract.

- B. All equipment, material and labor required for testing a plumbing system or part thereof shall be furnished by the Plumbing Contractor responsible for installing the work.

3.2 INTERIOR PIPING

A. Drainage Piping:

Rough Plumbing: The piping of all plumbing storm, condensate waste, sanitary drainage and venting systems shall be tested upon completion of the rough piping installation by water or air and proved watertight. Where required by the code official, the cleanout plugs shall be removed to ascertain if the pressure has reached all parts of the system. Either of the following methods shall be used:

1. **Water Test:** The water test shall be applied to the drainage system either in its entirety or in sections after rough piping has been installed. If applied to the entire system, all openings in the piping shall be closed, except the highest opening, and the system filled with water to the point of overflow. If the system is tested in sections, each opening shall be plugged except the highest opening of the section under test, and each section shall be filled with water, but a section shall not be tested with less than a 10-foot head of water.

In testing successive sections, at least the upper 10 feet of the next preceding section shall be tested, so that a joint or pipe in the building (except the uppermost 10 feet of the system) shall not have been subjected to a test of less than a 10-foot head of water. The water shall be kept in the system or in the portion under test for a minimum of 15 minutes before inspection starts. The system shall then be tight at all points.

2. **Air Test:** The air test shall be made by attaching an air compressor testing apparatus to an opening, and, after closing all other inlets and outlets to the system, forcing air into the system until there is a gauge pressure of 5 pounds per square inch (5 psi) or a minimum of 10-inch column of mercury. This pressure shall be held without introduction of additional air for a minimum period of 15 minutes.

Precautionary Note: The compressibility of air and/or other gases result in tremendous amounts of stored energy, even at lower pressures. Over-pressurizing creates a substantial hazard to personnel and property near the area should a failure occur. Consult with the Plastic Pipe Institute (PPI) for statements and alerts, along with State and local safety offices.

Finished Plumbing: Where required by the code official, after the plumbing fixtures have been set and their traps filled with water, their connections shall be tested and proved gas and water-tight by one of the following test methods.

1. The final test for gas and water-tightness of the completed drainage and vent systems shall be made by a smoke test or other approved method. The test shall be made by filling all traps with water, and then introducing into the system smoke produced by one or more smoke machines. When the smoke appears at stack openings on the roof, the stack openings shall be closed and a pressure equivalent to a 1" water column shall be built and maintained for the period of the inspection.
2. After the plumbing fixtures have been set and their traps filled with water, their connections shall be tested and proven gas and water-tight by plugging the stack openings on the roof and building drain where the drain leaves the building and with air introduced into the system equal to the pressure of a 1-inch water column. This shall be accomplished by the use of a "U" tube or manometer inserted in the trap of a water closet. Such pressure shall remain constant for the period of inspection without the introduction of additional air.

Building sewer test: The building sewer shall be tested by insertion of a test plug at the point of connection with the public sewer or individual sewage disposal system. The building sewer shall

then be filled with water under a head of not less than 10 feet. The water level at the top of the test head of water shall not drop for at least 15 minutes.

- B. Domestic Water Piping: All new, altered, extended or replaced interior water piping installed shall be tested at 100 psig maintaining the pressure for four hours with not more than 1% drop in pressure. The system shall be filled with water which shall remain in the system until the water and the piping are the same temperature. If water pipe testing is under the jurisdiction of the local inspector, his requirements shall be used; however, they shall be not less than specified herein. The tests shall be performed in the presence of the representative of the Architect/Engineer and to his satisfaction.
- C. Natural Gas Piping:
 - 1. All new, altered, extended or replaced interior natural gas piping installed shall be tested in accordance with the requirements of the National Fire Protection Association, latest edition of the IFGC, Section 107, and the requirements of the local Utility Company as applicable. In the absence of a specific test required by the Authorities, or if such requirements are less stringent than the test hereinafter specified, then the interior gas piping shall be tested as follows in the presence of the representative of the Architect.
 - 2. Before appliances are connected, piping shall be filled with air or nitrogen, to a pressure of 10 psi and proved tight with no drop in pressure for the length of time required to inspect the joints, but in no case less than 30 minutes. The source of pressure shall be isolated before the pressure tests are performed. Pressure shall be measured with a mercury manometer, or slope gauge or equivalent device so calibrated as to be read in increments of not greater than one-tenth pound. All piping which will be concealed shall be tested, prior to being closed in by construction.

3.3 EXTERIOR PIPING

- A. Sanitary & Storm Water Drainage Piping:
 - 1. All new exterior sanitary and storm water drainage installed shall be tested in a manner and in a sequence best suited to project. The test shall be performed in the presence of the Inspector of the Municipality under whose jurisdiction the installation is made and shall conform to his requirements.
 - 2. In the absence of a specific code test, the Contractor shall perform the following testing in the presence of the representatives of the Architect.
 - 3. Before any section of sanitary and storm water drainage has been backfilled more than 6 inches above the top of the pipes, exclusive of the joint area, the system shall be tested. Wherever possible, the section of the system shall be tested from manhole to manhole. The lower end of each section to be tested shall be plugged with a suitable device manufactured for this purpose. The section being tested shall be filled with water and the leakage observed and gauged.
 - 4. For the gravity sanitary drainage piping to be acceptable, the water leakage after filling shall not exceed 2 gallons per 24 hours per lineal foot of pipe joints with all joints under a constant pressure of not less than 0.1 pound.
 - 5. For the storm water to be acceptable, the water leakage after filling shall not exceed 3 gallons per 24 hours per lineal foot of pipe joints with all joints under a constant pressure of not less than 0.1 pound.
- B. Water Service: All new exterior water service piping installed shall be tested and proved tight. In the absence of specific requirements or requirements less stringent than those specified herein, this contractor shall test the domestic water service piping at a minimum pressure of 125 psig maintaining the pressure for two hours without more than 2% drop in pressure. The 6" water service from the wet tap to the 6" sprinkler service entry location shall be tested in accordance with the NFPA requirements of at least 200 psi. The systems shall be filled with water which shall remain in the system until the water and piping are the same temperature.

C. Gas Service:

1. All new exterior distribution piping, installed by this Contractor, for natural gas systems shall be tested in accordance with the requirements of the National Fire Protection Association, latest edition of the IFGC, Section 107, and the requirements of the local Utility Company. In the absence of a specific test required by the Authorities, or if such requirements are less stringent than the test hereinafter specified, then the exterior piping shall be tested as follows, before pressure regulating valves are installed, or connection made to interior piping.
2. Piping shall be filled with air or nitrogen, to a pressure of 100 psi, and proved tight with no drop in pressure for the length of time required to inspect the joints, but in no case less than one hour. The source of pressure shall be isolated before the pressure tests are performed. Pressure shall be measured with a gauge so calibrated as to be read in increments of not greater than one pound.

3.4 STERILIZATION

- A. After final testing for leaks, all new potable water piping installed including water service piping, shall be flushed to remove foreign material.
- B. Before placing domestic water systems in service, a qualified service organization shall be engaged, to sterilize the entire building including the exterior water service piping in accordance with the following procedure:
 1. Contractor shall provide a 3/4" hose connection somewhere in the main entering the building, or in the Mechanical Room and/or in the meter pit, pump in sufficient sodium hypochlorite to produce a free available chlorine residual of not less than 100 PPM.
 2. Proceed upstream from the point of chlorine application opening all faucets and taps until chlorine is detected. Close faucets and taps when chlorine is evident. Consult with the local code department for additional concentrations and durations.
 3. When chlorinated water has been brought to every faucet and tap with a minimum concentration of 200 PPM chlorine, retain this water in the system for at least three hours.
 4. At the end of the retention period, no less than 100 PPM of chlorine shall be present at the extreme end of the system.
 5. Proceed to open all faucets and taps and thoroughly flush all new lines until the chlorine residual in the water is less than 1.0 PPM.
 6. Obtain representative water samples from the system for analysis by a recognized Bacteriological Laboratory.
 7. If all samples tested for impurities and organisms are negative, a letter and laboratory reports shall be submitted by the service organization to the contractor, certifying successful completion of the sterilization.
 8. If any samples tested indicate the presence of harmful impurities and organisms, the entire sterilization procedure shall be repeated.
 9. Plumbing Contractor shall provide plumbing connections and power for pumping chlorine solution into the system.

Warning: PVC and CPVC Pipe: Do not use a dry granular calcium hypochlorite as a disinfecting material for water purification in potable water piping systems. The introduction of granules or pellets of calcium hypochlorite with solvent cements and primers (including their vapors), may result in violent chemical reactions.

- C. Available Service Organizations: Subject to compliance with requirements, provide the sterilization service of one of the following:

Water Chem

Appoquinimink School District

Summit Campus
Middle and High School

Arc Company, Inc.

Nova Consultants

Artesian Water Co.

END OF SECTION

SECTION 22 01 91 BALANCING - PLUMBING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary and other conditions, if any) and Division 1 as appropriate, apply to the work specified in this Section.

1.2 DESCRIPTION OF WORK

- A. Extent of plumbing systems to be balanced is indicated on the drawings and by requirements of this section.
- B. Applications of tests include the following:
 - 1. Interior Piping
 - a. Domestic hot water and hot water return

1.3 REFERENCE STANDARDS

- A. Refer to Section 220000 for a general description of requirements applying to this section.

1.4 QUALITY ASSURANCE

- A. Refer to Section 220010 for a general description of requirements applying to this section.

1.5 SUBMITTALS

- A. Submit balancing report in accordance with Section 220000.

1.6 WARRANTY/GUARANTEE

- A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, GENERAL REQUIREMENTS.

PART 2 – PRODUCTS

2.1 PIPE & FITTING REPLACEMENTS

- A. Refer to Section 220010 for replacement of any defective pipe or fittings. Replacement shall include all required draining of system, removal and replacement and uncovering, recovering.

PART 3 – EXECUTION

3.1 GENERAL

- A. All new hot water return piping installed or wherever system valves are being replaced, the system shall be tested, balanced and approved before concealing. Failure to secure the approval of the Municipal Inspector, A/E Inspector or the Inspector of the Owner makes it mandatory for the Contractor to completely expose the piping for balancing. All expense involved in the uncovering of the piping for the balancing and recovering shall be borne by the respective Contractor with no change in Contract.
- B. All equipment, material and labor required for balancing a plumbing system or part thereof shall be furnished by the Plumbing Contractor responsible for installing the work.

3.2 INTERIOR PIPING

- A. Domestic Hot Water Return System: Upon completion of the testing of the domestic hot water supply and recirculation systems, a final procedure is to be performed to obtain uniform circulation within each hot water loop of the domestic hot water system. At the ends of the hot water mains, or wherever a branch return line connects to the main return line, there shall be three (3) valves: ball valve, check valve and balancing valve. These valves are to be installed in an accessible space at/or

above the ceiling or where indicated on the drawings.

- B. Based on an Accu-Flo balancing valve, the use of a differential pressure gauge Model No. 779 shall be used to achieve the greatest accuracy.

END OF SECTION

SECTION 23 02 00
GENERAL PROVISIONS – HVAC

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to work of this Section.
- B. This specification or drawing and the design features or resulting construction disclosed, are the property of Furlow Associates, Inc., and shall not be reproduced without written permission.
- C. All Mechanical Systems shall be part of and included in all of the following: 230200 thru 230950.

1.2 WORK INCLUDED

- A. Provide labor, materials, equipment and supervision necessary to install complete operating HVAC Systems, including all work at the site and within the proposed construction areas to accomplish the required work.
- B. Wherever the term "provide" is used, it shall be understood to mean both "furnish" and "install".

1.3 REGULATIONS, CODES AND STANDARDS

- A. Work shall be performed in accordance with latest adopted codes, regulations and ordinances by authorities having jurisdiction. Observe all safety regulations.
- B. Obtain all permits and inspection certificates and pay all charges.
- C. Latest editions of any referenced standards shall govern.

1.4 RELATED WORK

- A. Refer to equipment shown or specified in sections of Division 1 thru 14 and 26 that will require Mechanical services and provide such service.
- B. Refer to work related to HVAC as shown on the following contract drawings:
Architectural & Structural
Plumbing
Electrical
- C. This Contractor shall coordinate with the work of Division 26 and the Fire Alarm System vendor for locations and mounting of all duct smoke detectors. These devices are shown on the Mechanical Drawings for reference only to show the intent of the work. All locations shall be determined based on approved shop drawings from the Fire Alarm System vendor and the Contractor for the work of Division 26, Electrical.

1.5 COORDINATION

- A. The Mechanical, Plumbing and Electrical Contractors are responsible to coordinate all manufacturer's recommended circuit breakers, starters, disconnects and fuse sizes for all equipment. Submission of a shop drawing will certify that this has been completed. Any necessary changes required will be included as part of this contract.
- B. Mechanical Contractor shall coordinate scheduling, submittals and work of the various sections of the Project Manual to ensure efficient and orderly sequence of installation of independent work elements, with provisions to accommodate items that may be installed at a later time.
- C. Mechanical Contractor shall verify utility requirements and all characteristics of operating equipment are compatible with the building utilities. Coordinate the work of all sections related and required for installing, connection and placing in service of all equipment.

- D. Mechanical Contractor shall coordinate all space requirements, supports and installation of all mechanical, electrical, plumbing and fire protection work, which are indicated diagrammatically on the Drawings. Verify routing of all pipes, ducts, conduits and equipment connections. Maximize accessibility for other work, and service requirements for maintenance and repairs. Develop overall coordination drawing (all trades) and submit for review prior to fabrication/installation.
- E. Obtain written confirmation from all related trade Contractors and the Owner or his representative that requirements, conflicts and coordination issues have been discussed and resolved.
- F. Submit coordination drawings to verify access and clearances.

1.6 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installation within unheated shelters.

1.7 SUBMITTALS

- A. Shop Drawings:
 - 1. Shop drawings shall be submitted in accordance with Division 1 of these specifications except where herein modified.
 - 2. Shop drawings comprising complete catalog cuts, performance test data for HVAC equipment as required by other sections of Division 23, shall be submitted for review checking. The Contractor shall review these shop drawings for conformance to contract documents prior to submission and affix contractor's signature to each submittal certifying that this review has been done. By approving and submitting shop drawings, product data, samples and similar materials, the Contractor represents that the Contractor has determined and verified materials, field measurements and field construction data that relates to the work, and has checked and coordinated this information with all of the requirements contained in the contract documents for the work of all trades.
 - a. The Contractor and equipment manufacturer shall clearly identify in all submittals and shop drawings any and all applications standards which require additional work to accommodate this equipment and provide a complete and operational system as described in the contract documents.
 - b. The Contractor shall be completely responsible for any and all additional costs associated with the changes required by this and all other trades.
 - 3. Submit a 1/4" scale layout of all mechanical equipment rooms. All equipment and pads shall be to scale of equipment being furnished. Obtain size information of any and all equipment from other trades and indicate on drawings. The drawings shall be fully coordinated with all trades prior to submission. Indicate coil pull areas, filter pull areas, maintenance clearances, and access as applicable.

4. All shop drawing submittals shall have the following identification data, as applicable, contained therein or permanently adhered thereto.
 - a. Project name.
 - b. Project number.
 - c. Sub-contractor's, vendor's and/or manufacturer's name and address.
 - d. Product identification.
 - e. Identification of deviation from contract documents.
 - f. Applicable contract drawings and specification section number.
 - g. Shop drawing title, drawing number, revision number, and date of drawing and revision.
 5. Resubmit revised or additional shop drawings as requested.
 6. Wherever shop drawings or vendor's standard data sheets indicate work to be done "by others", it shall be the responsibility of the contractor making the submission to identify by name, the contractor who is to do this work. If the contractor named is other than the contractor making the submission, the shop drawing submission must be reviewed by the named contractor and bear his mark of approval, prior to submission to the Architect/Engineer.
 7. Where equipment proposed differs from that shown on the drawings or specified, he shall submit for approval drawings showing the manner in which the layout is affected by the substitution.
 8. The Contractor shall keep one copy of approved shop drawings at the job site,, filed in a suitable metal container. The shop drawings shall be cataloged and kept in good repair, and shall be available for use by the Owner, Architect and Engineer.
 9. No equipment shall be ordered, fabricated, etc., before approval of shop drawings.
 - B. Contractor is responsible for the shop drawing coordination and interface with the work of other contracts and adjacent work. The relationship of Contractor's work shall be verified as it relates to adjacent and critical features of the work of this and all contracts and materials.
 - C. The Contractor shall submit a complete schedule of all shop drawings required for the scope of work covering all materials and equipment listed in all sections of Division 23, Mechanical, including all documents required for contract closeout, Owner instructions and training, and all turnover items at the completion of the work. This schedule shall be submitted for review and approval within thirty days of contract award and before any subsequent materials are provided for review.
 - D. The shop drawings provided by the Contractor will be reviewed only once and resubmittals will be reviewed only once. Any other submittals will be billed to the Contractor at the Engineer's standard rates.
- 1.8 SUBSTITUTIONS
- A. Whenever a material, article, piece of equipment or system is identified in the following specification or indicated on the drawings by reference to manufacturers' or vendors' names, trade names, catalog numbers or the like, it is so identified for the purpose of establishing the basis of the Bid.
 - B. Substitution approval must be obtained and included as an addendum item prior to the submission of the bid. An approved substitution shall not be considered as an approval for the Contractor or an equipment vendor to deviate from the written portion of the specifications unless so stated in the addendum.
 - C. The drawings illustrate the space allocated for equipment and the Contractor shall install the equipment accordingly. If changes are required in the building or arrangement due to substitution of equipment, the Contractor making the substitution must pay for the necessary modifications.

- D. The listed equivalent or substituted manufacturers along with the bidding related contractor shall be completely responsible to comply with all requirements on all contract documents. This shall include, but not be limited to all: space requirements, code clearances, type-horsepower-capacities-number and size of services required from other trades including all auxiliary items provided by this Contractor and all other trades, and all manufacturer's specific equipment applications standards and requirements, for approved equipment including that which is basis of design or a substitution. The bidding related contractor and equipment manufacturers shall clearly identify in all submittals and shop drawings any and all applications standards which require additional work to accommodate this equipment and provide a complete and operational system as described in the contract documents. If the bidding contractor or manufacturer does not comply with these requirements then they shall be completely responsible for any and all additional costs associated with the changes required by this and all other trades.

1.9 LUBRICATION

- A. Provide and maintain all required lubrication of any equipment operated prior to acceptance by the Owner. Lubrication shall be as recommended by the equipment manufacturer.
- B. Provide one year's supply of lubricants to Owner at date of acceptance.
- C. Verify that required lubrication has taken place prior to any equipment start-up.

1.10 EQUIPMENT START-UP

- A. Verify proper installation by manufacturer or his representative.
- B. Advise Construction Manager 2 days prior to actual start-up.
- C. Verify proper operation. Obtain signed statement by manufacturer or his representative that equipment is operating within warranty requirements. Submit statement to Construction Manager.
- D. Perform field mechanical balancing in accordance with Section 230950: TESTING AND BALANCING OF MECHANICAL SYSTEMS.
- E. The Mechanical Contractor shall own as part of his work, the following:
Provide one (1) additional drive set, if necessary, to obtain final design balancing requirements. The Mechanical Contractor shall coordinate with Balancing Firm and equipment manufacturer for drive selection, including belts and pulleys.

1.11 OPERATION & MAINTENANCE INSTRUCTIONS

- A. Properly and fully instruct Owner's personnel in the operation and maintenance of all systems and equipment.
- B. Insure that the Owner's personnel are familiar with all operations to carry on required activities.
- C. Such instruction shall be for each item of equipment and each system as a whole.
- D. Provide report that instruction has taken place. Include in the report the equipment and/or systems instructed, date, contractor, Owner's personnel, vendor, and that a complete operating and maintenance manual has been reviewed.
- E. Manual shall include all instructions on operation, maintenance, repair parts list, lubrication requirements, brochures, catalogue cuts, complete schedule of air filters for each unit type in Excel spreadsheet format, wiring diagrams, piping diagrams, control sequences, service requirements, names and addresses of vendors, suppliers and emergency contacts. Three manuals shall be provided.
- F. Submit manuals for review prior to operating instruction period. Manuals shall be 8-1/2 x 11" with hard cover, suitably bound.
- G. Provide to the Owner any special tools necessary for operation and routine maintenance of any of the equipment.

- H. Upon completion of the project, the Mechanical Contractor shall provide a complete set of legible as-built drawings for the Owner.

1.12 TOOLS

- A. All equipment furnished by the Mechanical Contractor which requires special tools or devices other than those normally available to the maintenance or operating staff shall be furnished in duplicate to the Owner, sufficiently marked, packed or boxed for staff usage. The tools provided shall be listed by the Mechanical Contractor identified as to their use or the equipment applicable in a written transmittal to the Owner.

1.13 FILTERS (ATTIC STOCK)

- A. Mechanical Contractor shall provide one (1) spare set of air filters for each unit for Owner's attic stock.

1.14 CLEANING AND FINISHING

- A. After equipment start-up and all operating tests have been made and the system pronounced satisfactory, each respective Contractor shall go over the entire project, clean all equipment, etc., installed by him and leave in a clean and working condition. Any surfaces found marred after this final cleaning shall be refinished or replaced by each Contractor at no cost to the Owner.
- B. Provide for the safety and good condition of all materials and equipment until final acceptance by the Owner. Protect all materials and equipment from damage. Provide adequate and proper storage facilities during the progress of the work. Special care shall be taken to provide protection for bearings, open connections, pipe coils, pumps, compressors and similar equipment.
- C. All fixtures, piping, finished surfaces and equipment shall have all grease, adhesive labels and foreign materials removed.
- D. All piping shall be drained and flushed to remove grease and foreign matter. Pressure regulating assemblies, traps, and similar items shall be thoroughly cleaned. Remove and thoroughly clean and reinstall all liquid strainer screens after the system has been in operation ten (10) days.
- E. Clean-up: Remove from the premises, all unused material and debris resulting from the performance of work under this section.

PART 2 – PRODUCTS

2.1 GENERAL

- A. All material and equipment shall be new and of present-day manufacture, and shall conform to accepted standards of the trade where such a standard has been established for the particular type of equipment or material.
- B. Whenever equipment or material is referred to in the singular, such as "the fan", it shall be deemed to apply to as many such items as necessary to complete the work.

2.2 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. During loading, transporting and unloading exercise care to prevent damage to material.
- B. Store all materials in dry enclosures or under protective coverings out of way of work progress.
- C. Material shall not be allowed to be stored directly on ground.
- D. Deliver in manufacturer's original cartons or on skids.
- E. Handle and protect so as to prevent damage to product or any surrounding material.

2.3 CONCRETE

- A. Concrete shall be in accordance with Section 03300.

2.4 WARRANTY

- A. Wherever in the specification sections of this division, reference is made to a specific warranty period, this warranty shall be in addition to and not a limitation of other rights the Owner may have against the Mechanical Contractor under the contract documents.

PART 3 – EXECUTION

3.1 PROTECTION

- A. Plug or cap open ends of piping systems, conduit and ductwork.
- B. Stored materials shall be covered to prevent damage by inclement weather, sun, dust or moisture.
- C. Protect all installed work until accepted in place by the Owner.
- D. Plates, polished metal escutcheons, thermostats and other finished devices shall not be installed until masonry, tile, and painting operations are complete unless otherwise protected.
- E. Protect all work from operations which may cause damage such as hauling, welding, soldering, painting, insulating and covering.

3.2 WORKMANSHIP

- A. Install all work neat, trim and plumb with building lines.
- B. Install work in spaces allocated.
- C. Cutting and patching shall be performed by skilled tradesmen normally employed for the work involved.
- D. This Contractor shall provide a complete weathertight seal to all new systems in the building including the necessary caulking, weather-stripping and insulation.

3.3 EQUIPMENT SETTING

- A. Provide as a minimum, a 4-inch concrete pad beneath all floor-mounted equipment. Install anchor bolts in pour.
- B. Provide as a minimum, spring vibration isolation and concrete inertia pad under any equipment 7.5 HP and over and is also located above grade. Provide rubber in shear vibration isolation on any equipment up to 7.5 HP that is located on grade. For further specifications and additional requirements, refer to other sections.
- C. Concrete shall be 3,000 psi, 28-day compressive strength in accordance with ACI-613. Reinforce with No. 4 rod 12" on centers both ways or as otherwise detailed.

3.4 FASTENERS, HANGERS AND SUPPORTS

- A. Provide all hangers and supports required to suspend, mount, or hang the work. Drilling into the roof deck is not permitted.
- B. Provide all miscellaneous steel angles, channels, beams, clips, brackets and anchors necessary to hang or support the work. Provide submissions for review.
- C. Install concrete inserts before concrete is poured.
- D. Drilled inserts shall not be loaded more than 1/4 rated capacity.
- E. Power-driven fasteners shall not be allowed for piping larger than 2 inch, or equipment. When used they shall not be loaded more than 1/8 rated capacity or 200 pounds.
- F. All hangers, miscellaneous steel, braces and supports shall be galvanized, cadmium plated, or primed steel. Copper tubing shall be supported with copper hangers.
- G. Piping shall be supported from adjustable clevis type hangers with insulation pipe saddles or pipe shields in accordance with piping support spacing table on the drawings. Where hangers are 18" or longer provide lateral bracing at every fourth hanger.

- H. Support vertical piping at floor levels. Piping shall have split rings.
- I. Any lintels required for openings for this work if not indicated on Architectural or Structural drawings shall be provided under this Section.

3.5 SLEEVES

- A. Provide each pipe, duct or conduit passing through a masonry or concrete wall, floor or partition with a sleeve made from standard weight steel pipe for pipe or conduit and No. 12 gauge galvanized steel for ducts, with smooth edges, securely and neatly cemented in place. Provide each pipe, duct or conduit passing through a frame or metal partition with a sleeve made from No. 22 gauge galvanized sheet metal, securely fastened in place.
- B. Be responsible for the proper location and alignment of all sleeves.
- C. Provide hydrostatic seals for sleeves passing through outside walls, either above or below grade, or through hydrostatically sealed slabs or floors on grade. Provide fire-rated seals for all sleeves which penetrate fire-rated walls.
- D. Install both piping and sleeve seals so as to maintain integrity of seals with expansion and contraction of piping.
- E. Extend wall and partition sleeves through and cut flush with each surface unless otherwise indicated or specified.
- F. Select sleeves two pipe sizes larger than any pipe or conduit that is to remain uncovered, unless otherwise required by the sealing method specified. Where pipes are to be covered, provide sleeves large enough to allow the covering to pass through the sleeves with sufficient clearance for sealing as specified hereinafter.
- G. Select duct sleeve sizes to suit requirements of fire dampers and sealing methods as specified.
- H. Place sleeves imbedded in concrete floors or walls in the forms before concrete is poured; sleeves shall have integral waterstop flanges, where they are to receive either watertight or hydrostatic seals.
- I. Hydrostatic Sealing Method: Provide compressible synthetic rubber seals, equivalent to LINK SEAL, manufactured by the Thunderline Corporation, or THRUWALL manufactured by O.Z. Gedney. Install seals in accordance with the manufacturer's recommendations to provide air tightness aboveground and hydrostatic sealing belowgrade. Caulking or other type mastic is not acceptable.
- J. Fire-Rated Sealing Method:
 - 1. Sleeves, openings and sealants shall comply with applicable codes, recommended practices and standards, and manufacturer's instructions. Fire sealants shall have ability to prevent spread of flame, smoke or water throughout the penetration and shall pass 3 hour test, UL test ASTM E814 and UL 1479.
 - 2. Products: Chase Corporation CTC PR-855, O. Z. Gedney CRS/CAFS, 3M Electro-Products Division Putty 303 or Caulk CP25 penetration sealing kits, General Electric Company sealants type RTV-850, 6428 or 7403, Thunderline Corporation "Link-Seal Pyro-Pak". Installation and type of sealant to be used as recommended by the manufacturer.

3.6 PLATES

- A. Provide chrome plated plates wherever piping passes into finished area.
- B. Plates shall be securely fastened to piping or building construction.
- C. Floor plates shall cover 1 inch sleeve extension.

3.7 OFFSETS, TRANSITIONS, MODIFICATIONS

- A. Provide all offsets necessary to install the work and to provide clearance for other trades.
- B. Maintain adequate headroom and clearance.

- C. Incidental modifications necessary to the installation of the systems shall be made as necessary and as approved by the Architect.

3.8 RECESSES

- A. Furnish information to the Construction Manager as to sizes and locations of recesses required to install panels, boxes, and other equipment or devices which are to be recessed in walls.
- B. Make offsets or modifications as required to suit final locations.

3.9 LABELING

- A. All HVAC equipment such as pumps, fans, air handling units, and devices requiring identification for operating procedures shall be provided with permanent black laminated micarta white core labels with 3/8-inch letters.
- B. This shall also apply to all controllers, remote start/stop pushbuttons and equipment cabinets.
- C. This shall not apply to individual room thermostats.
- D. All Mechanical Rooms shall be identified with a permanent placard of red-white-red laminated, commercial grade, plastic construction. Letters shall be minimum one inch high and read in capital letters: WARNING – MECHANICAL EQUIPMENT ROOM – LIMITED ACCESS. Placard shall be centered on each door leading into the mechanical room at five feet above the floor and attached at each corner with brass screws.
- E. At all fire damper locations, access doors in ductwork shall be identified with a permanent placard of red-white-red laminated commercial grade plastic construction, minimum one-half inch high capital letter, reading, "FIRE DAMPER" as appropriate for the installation. Attach securely to face of access door with brass screws at each corner, sealed airtight.

3.10 FLASHING AND COUNTERFLASHING

- A. Roof curbs, etc., shall have counterflashing fittings. General Contractor shall provide flashing.
- B. Piping and conduit thru the roof shall be flashed by the General Contractor. Provide counterflashing.
- C. Provide curbs with base features required to match roof materials, finishes and configuration; e.g., flat, sloped, raised seam, etc.

3.11 ACCESS

- A. Locate all equipment, valves, devices and controllers which may need service in accessible places.
- B. Where access is not available, access panels shall be provided. Furnish access panels to the Construction Manager for installation.
- C. Access panels shall be Nailor-Hart Industries, Karp Co., or Controlled Air Manufacturing Limited, with 16-gauge frames and 14-gauge steel door, prime painted.
- D. Maintain access clearances for tube or fan removal, coil pulls, and filter removal.

3.12 WIRING AND MOTOR CONTROLS

- A. Packaged equipment shall be furnished with disconnect switches, starters, overloads, factory furnished and wired by the unit manufacturer.
- B. Roof-mounted exhaust fans, except utility sets, rated less than 1/2 HP at 115 volts, single phase, shall be furnished with disconnect switches, factory furnished and wired by unit manufacturer.
- C. Rooftop equipment shall be furnished with starters, disconnect switches, overloads, factory furnished and wired by unit manufacturer.
- D. All wiring shall be in accordance with the National Electrical Code and as recommended by the equipment manufacturer.

3.13 OPENINGS – CUTTING, REPAIRING

- A. This Contractor shall cooperate with the work to be done under other sections in providing information as to openings required in walls, slabs and footings for all piping, ductwork and equipment, including sleeves where required.
- B. Any drilling or cutting required for the performance of work under this Section, shall be the responsibility of this Contractor and the cost thereof shall be borne by him.
- C. Holes in Concrete: Sleeves shall be furnished, accurately located and installed in forms before pouring of concrete. This Contractor shall pay all additional costs for cutting of holes as the result of the incorrect location of sleeves. All holes through concrete shall be either core drilled or saw cut. All holes required shall have the approval of the Structural Engineer prior to cutting or drilling.
- D. It shall be the responsibility of this Contractor to ascertain that all chases and openings are properly located.

3.14 PAINTING

- A. Refer to the Construction Manager's Scope of Work.

3.15 GUARANTEE

- A. All work shall be guaranteed to be free from defects for a period of two years of operation from date of acceptance by the Owner.
- B. Guarantee shall be extended on an equal time basis for all non-operational periods due to failure within the guarantee period.
- C. All materials and equipment provided and/or installed under this section of the specifications shall be guaranteed for a period of two years from date of acceptance of the work by the Owner unless otherwise specified in Division 1. Should any trouble develop during this period due to defective materials or faulty workmanship, the Mechanical Contractor shall furnish necessary labor and materials to correct the trouble without any cost to the Owner. Any defective materials or inferior workmanship noticed at time of installation and/or during the guarantee period shall be corrected immediately to the entire satisfaction of the Owner.
- D. In the event of occupancy by the Owner prior to final acceptance of the project, the guarantee date for equipment placed in operation shall be mutually agreed to by the Mechanical Contractor and the Owner's representative.

3.16 DRAWINGS

- A. The Mechanical Systems are indicated on the Contract Drawings. Certain pertinent information and details required by the Mechanical Work appear on the Architectural, Structural and Electrical Drawings; become familiar with all drawings, and incorporate all pertinent requirements.
- B. Drawings are diagrammatic and indicate the general arrangement of systems and requirements of the work. Do not scale drawings. Exact locations of fixtures and equipment, not specifically shown, shall be obtained before starting work.

3.17 TESTING AND BALANCING OF MECHANICAL EQUIPMENT

- A. The Mechanical Contractor shall own as part of his work, the following:
Provide one (1) additional drive set, if necessary, to obtain final design balancing requirements. The Mechanical Contractor shall coordinate with Balancing Firm and equipment manufacturer for drive selection, including belts and pulleys.

END OF SECTION

SECTION 23 02 05**POLYPROPYLENE WATER PIPING (Basis of Design)****PART 1 – GENERAL****1.1 SUMMARY**

- A. This Section includes pipe and fitting materials, joining methods and specialty items for the following:
 - 1. Hot-water heating piping.
 - 2. Chilled Water piping.
 - 3. Dual Temperature Piping
 - 4. Make-up water piping
 - 5. Air Vent piping
 - 6. Safety-Valve-Inlet and -Outlet Piping

1.2 RELATED SECTIONS

- A. Drawings and general provisions of the Contract, including General Conditions, Supplementary Conditions, and General Requirements apply to work of this section.

1.3 REFERENCE DOCUMENTS

- A. ASTM F 2389-21 - Standard Specification for Pressure-rated Polypropylene (PP-RCT) Piping Systems
- B. CSA B137.11 - Polypropylene (PP-R) Pipe and Fittings for Pressure Applications
- C. NSF/ANSI 14 – Plastic Piping System Components and Related Materials

1.4 DEFINITIONS

- A. Definitions shall be in accordance with local mechanical codes and ASTM F 2389-21.

1.5 SUBMITTALS

- A. Material list naming each product to be used identified by manufacturer and product number, in accordance with Section 230200.

1.6 QUALITY ASSURANCE

- A. Material shall be certified by NSF as complying with NSF 14, ASTM F 2389-21 and CSA B137.11.
- B. Material shall comply with manufacturers specifications.
- C. NSF shall certify special engineered products as complying with NSF 14.

PART 2 – PRODUCTS**2.1 PIPE AND PIPING PRODUCTS**

- A. Pipe shall be manufactured from a high-quality Polypropylene Random Co-Polymer produced using Borealis RA-7050 “Beta (β) nucleated” (hexagonal crystalline structure) PP-RCT resin, meeting the short-term properties and long-term strength requirements of ASTM F 2389-21. The pipe shall contain no rework or recycled materials and manufactured only from “virgin” resins. All pipes shall be made in a three-layer extrusion process. All pipes shall comply with the rated pressure requirements of ASTM F 2389-21. All pipe shall be certified as complying with NSF 14, ASTM F 2389-21 and CSA B137.11.
- B. Hot water, chilled water, and dual temperature pipe shall be NUPI Americas NIRON Clima PP-RCT ‘SDR-9’ or ‘SDR-7.3’ (3/4” only) with a central Powercore™ layer containing added fiberglass (to reduce thermal expansion), available from NUPI Americas.

2.2 FITTINGS

- A. Injection molded fittings shall be provided on all fittings through 12" diameter unless otherwise approved as a "custom fitting" and shall be produced using Borealis RA-7050 Beta – nucleated (hexagonal crystal structure) PP-RCT resin. The fittings shall contain no rework or recycled materials and manufactured only from "virgin" resins by NUPI Americas. All fittings shall be certified by as complying with NSF 14, NSF 6 and ASTM F 2389 or CSA B137.11.
- B. Fittings larger than 12" diameter shall be fabricated by NUPI Americas using the same piping material furnished for the piping application and complying with NSF 14, NSF 61, NSF 51 and ASTM F 2389-21 or CSA B137.11.

2.3 WARRANTY

- A. Manufacturer shall warrant pipe and fittings for 30 years to be free of defects in materials or workmanship.

PART 3 – EXECUTION

3.1 PIPING APPLICATIONS

- A. Install listed pipe materials and joining methods below in the following applications:
 - 1. Aboveground Piping: Polypropylene (PP-RCT) piping in SDR 9 based on the required minimum pressure rating and use temperature, in accordance with manufacturer's instructions and ASTM F2389-21.

3.2 FUSION WELDING OF JOINTS

- A. Install fittings and joints using socket-fusion, electro-fusion, or butt-fusion as applicable for the fitting or joint type. All fusion-weld joints shall be made in accordance with the pipe and fitting manufacturer's specifications and product standards.
- B. Fusion-weld tooling, welding machines, and electrofusion devices shall be as specified by the pipe and fittings manufacturer.
- C. Prior to joining, the pipe and fittings shall be prepared in accordance with F 2389-21 and the manufacturer's specifications.
- D. Joint preparation, setting and alignment, fusion process, cooling times and working pressure shall be in accordance with the pipe and fitting manufacturer's specifications.

3.3 PIPING INSTALLATIONS

- A. Install hangers and supports at intervals specified in the applicable Mechanical Code and as recommended by pipe manufacturer.
- B. Support vertical piping at each floor and as specified in the applicable Mechanical Code.
- C. Fire stopping shall be provided to both be compatible with the Nupi Piping and meet the requirements of ASTM E 814 or ULC S115, "Fire Tests of Through-Penetration Firestops".
- D. If heat tracing or freeze protection is specified for the piping, it should be installed on the pipe interior or exterior, and it must be suitable for use with plastic piping and self-regulating to ensure the surface temperature of the pipe and fittings will not exceed 70°C (158°F).
- E. While still accessible all piping shall be pressure/leak tested to the manufacturer's standards. Tests shall be carried out using water, compressed air or a mixture of the two. The test pressure shall be 1.5 times the operating pressure or 150 psi whichever is greater. Any leaks detected shall be repaired at the contractor's expense by removing the leaking part and replacing with new parts welded per the pipe manufacturer's guidelines.

3.4 INSPECTING AND CLEANING

- A. The pipes should be flushed with cold water after finishing the installation. Inspect and test piping systems following procedures of authorities having jurisdiction and as specified by the piping system manufacturer.

END OF SECTION

SECTION 23 02 10

BASIC MATERIALS AND METHODS – HVAC

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary and other conditions, if any) and Division 1 as appropriate, apply to the work specified in this section.
- B. Refer to Section 230200 for HVAC General Provisions.
- C. Refer to other sections in Division 23 for materials and methods not specified herein.

1.2 DESCRIPTION OF WORK

- A. Included in this Section are the following:
 - 1. Steel Pipe and Fittings
 - 2. Copper Tubing & Fittings
 - 3. Grooved End Pipe (Gruvlok) or (Victaulic)
 - 4. Strainers
 - 5. Thermometers
 - 6. Gauges
 - 7. Test Stations - Pressure/Temperature
 - 8. Isolating Fittings
 - 9. Pipe Saddles
 - 10. Anchors and Guides
 - 11. Flexible Expansion Loop (Manufactured)
 - 12. Unions
 - 13. Motors

1.3 REFERENCE STANDARDS

- A. Refer to Section 230200 for a general description of requirements applying to this section.
- B. Install work to meet the requirements of the following:
 - 1. New Castle County Dept. of License and Inspections
 - 2. International Mechanical Code
 - 3. Gas Utility Company
 - 4. NFPA
 - 5. OSHA
 - 6. ASHRAE
 - 7. Manufacturer's Standardization Society (MSS) of the valve and Fittings Industry, Inc.:
 - SP-58 Pipe Hangers and Supports Materials, Design and Manufacture.
 - SP-69 Pipe Hangers and Supports Selection and Application
- C. Appliances and materials governed by UL requirements shall meet such requirements and bear the label.

1.4 QUALITY ASSURANCE

- A. Provide adequate supervision of labor force to assure that all aspects of the specifications are being fulfilled.
- B. Verify that all work and equipment is installed in accordance with manufacturer's warranty requirements.

PART 2 – PRODUCTS

2.1 STEEL PIPE AND FITTINGS

- A. Water Piping:
 - 1. ASTM A53, Schedule 40.
 - 2. Fittings up to 2 inch shall be 150 lb. malleable iron, screwed pattern ASME B16.3. Butt weld, ASME B16.9, same thickness as pipe.
 - 3. Fittings 2-1/2" and larger shall be butt weld ASME B16.9, same thickness as pipe.
 - 4. Weld-O-Lets and Thread-O-Lets shall be maximum of two sizes smaller than main size; i.e., maximum of a 2-inch Weld-O-Let on a 3-inch pipe.
 - 5. Thread tape shall be teflon tape, 3 mils minimum thickness.

2.2 COPPER TUBING & FITTINGS

- A. Refrigeration Piping:
 - 1. Copper tubing: Type ACR, hard drawn temper.
 - 2. Fitting: Wrought-copper, solder joints, ASME B16.22 or ASME B16.26.
 - 3. Joints: Brazed, American Welding Society (AWS) Class BCUP-5 for brazing filler metal.
- B. Water Piping:
 - 1. Tubing: Hard drawn seamless ASTM B-88 Type "L" aboveground.
 - 2. Soft seamless ASTM B-88 Type "K" below-ground.
 - 3. Joint Material: Brazed joints, low temperature silver-bearing solder.
 - a. Flux shall be non-toxic type and non-corrosive.
 - 4. Fittings: ASME B16.15, B16.18, B16.22, or B16.26.
- C. Condensate Drain Piping:
 - 1. Pipe: Copper tubing Type DWV.
 - 2. Fittings: Wrought copper solder type drainage fittings, ASME B16.23 or B16.29.

2.3 GROOVED END PIPE (VICTAULIC)

NOTE: GROOVED END PIPE SHALL ONLY BE ALLOWED IN THE PENTHOUSE AND BETWEEN THE AIR-COOLED CHILLER AND MECHANICAL ROOM.

- A. All pipe shall be prepared in accordance with (ANSI/AWWA C-606). (CSA B242-M1980). (MIL-P-11087C Grooved End Pipe), or Victaulic (manufacturer's) published specifications as appropriate according to pipe materials, wall thickness, size and method of joining, as further detailed in Paragraph G: Pipe Preparation. In the event of conflict, Victaulic data shall prevail.
 - 1. Iron Pipe Size: Pipe shall conform in size (outside diameter) to ANSI B-36.10 (API-5L) and/or to Victaulic (Manufacturer's) published outside diameter tolerances.
 - a. Steel Pipe (CSI-15061): Steel pipe shall be black, conforming to ASTM A-53, Grade B, 3/4 - 1-1/2" (20-40 mm) Type F and 2 - 24" (50-600mm) Type E or S or hot-dip galvanized.

- B. Couplings shall consist of two ductile iron cast housings, a synthetic rubber gasket of a central cavity pressure-responsive design, with nuts, bolts, locking toggle or lugs to secure unit together.
1. Coupling Housings: Shall be cast of ductile iron conforming to ASTM A-536 (Grade 65-45-12) enamel coated, hot dip galvanized to ASTM A-153 or zinc electroplated to ASTM B-633, as manufactured by Victaulic Company of America. Refer to Victaulic product specifications for other materials.
 - a. Coatings: Shall consist of an enamel paint or hot dip galvanizing to ASTM A-153, or zinc electroplating to ASTM B-633 as specified.
 2. Couplings for End Steel Pipe: Shall be Victaulic couplings for grooved and steel pipe prepared under "Grooved End Pipe". Couplings shall comply with ASTM F1476 Standard Specification for the Performance of Gasketed Mechanical Couplings for Use In Piping Applications.
 - a. Sizes 2" through 12": Coupling housings cast with offsetting, angle pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with ANSI B31.1 and B31.9.
 - (1) Victaulic Style 107N, Installation-Ready, for direct stab installation without field disassembly, with grade EHP gasket, suitable for water service to +250 deg F.
 - b. Flexible Type: For use in locations where vibration attenuation and stress relief are required, thermal expansion and contraction, in riser piping, and for elimination of flexible connectors. Victaulic Installation-Ready Style 177N or Style 77.
 - c. 14" and Larger: AGS Series, with lead-in chamfer on housing key and wide width FlushSeal gasket. Victaulic Style W07 (rigid) with Coupling housing key designed to fill the wedge shaped AGS groove and provide system rigidity, and Style W77 (flexible).
 - d. Reducing Joints: Shall be Victaulic Style 750 Reducing couplings for pipe to pipe joints or to create reducing fittings using straight fitting configurations.
 - e. Outlets: All joints designed Outlet Couplings or where feasible to replace reducing outlet tees, shall be Victaulic Style 72 Outlet couplings male threaded outlet.
 - f. Flanged Connections: Shall be Victaulic Style 741 /W741 (2 - 24") Vic-Flange adapters, engaging directly into grooved pipe and bolting directly to ANSI Class 125 cast iron or Class 150 steel flanged components.
- C. Couplings for Grooved End Ductile Iron Pipe: Shall be Victaulic couplings for radius cut grooved ductile iron pipe preparation.
1. Line and Fittings Joints: Shall be Victaulic Style 31 couplings.
 2. Flanged Connections: Shall be Victaulic Style 341 (4-24") (100-600mm) Vic-Flange adapters, engaging directly into grooved end pipe and bolting directly to ANSI Class 125 cast iron or Class 150 steel flanged components. Installer to supply standard flange bolts.
 3. For direct connection to IPS steel pipe sizes, couplings shall be Victaulic Style 307 transition couplings.
- D. Coupling Components:
1. Gaskets shall be molded of synthetic rubber in a central cavity, pressure-responsive configuration conforming to the pipe outside diameter and couplings housing, of elastomers having properties as designated in ASTM D-2000. Reference always shall be made to the latest published selection guide for Victaulic gaskets for proper gasket selection for the intended service.
 - a. Water Service: Gasket supplied for water services from -30 deg. F to +230 deg F (-34 deg. C to +110 deg. C) shall be a Grade "E" EPDM compound, with green color code, molded of materials conforming to ASTM D-2000, designation 2CA615A25B24F172, recommended

- for hot water service within the specified temperature range, plus a variety of dilute acids, oil-free air, and many chemical services. Not recommended for petroleum services.
2. Bolts and Nuts shall be heat treated carbon steel, track head, conforming to physical properties of ASTM A-449 and A-183 minimum tensile 110,000 psi, zinc electroplated to ASTM B-633, as supplied or specified.
 - a. Other Fasteners: Fasteners to certain products may vary from the specification as noted with each product.
- E. Fittings: Shall be Victaulic full flow cast fittings, steel fittings or segmentally welded fittings with grooves or shoulders designed to accept Victaulic grooved end couplings and AGS couplings 14" through 24".
1. Standard Fittings: Shall be cast of ductile iron conforming to ASTM A-536 (Grade 65-45-12) painted with enamel or hot dip galvanized to ASTM A-153 or zinc electroplated to ASTM B-633 as required.
 2. Standard Steel Fittings: Including large size elbows (16-24"/400-600mm) shall be forged steel conforming to ASTM A-234 Grade WPB (0.375" wall), painted with enamel or hot-dip galvanized to ASTM A-153.
 3. Standard Segmentally Welded Fittings: Shall be factory-fabricated of Schedule 40 carbon steel pipe as follows: 3/4 - 1-1/2" (20-40mm) conforming to ASTM A-53 Type F, 2 - 10" (50 - 250mm) Schedule 40 conforming to ASTM A-53, Type E or S, Grade B, 12 - 24" (300 - 600mm) 0.375" wall conforming to ASTM A-53, Type E or S, Grade B, painted with enamel or hot-dip galvanized to ASTM A-153.
- F. Branch outlets for hole cut steel pipe: Shall be Victaulic hole cut products, cast of materials as in Paragraph 4a, with gasket as detailed in Paragraph 3c, on pipe preparation in Paragraph G.
- G. Gauge, Meter Outlets for Hole Cut Steel Pipe: Shall be Victaulic strapless mechanical outlet products Style 923 Vic-Let, or 924 Vic-O-Well and shall provide a pipe outlet without a need for a strap or lower housing to wrap around the pipe.
- H. Pipe Preparation: Shall be prepared in accordance with the latest published Victaulic specifications, ANSI/AWWA C-606, CSA B-242, UL, FM, NFPA or other standards as applicable. Pressure ratings and end loads for cut grooved pipe are based upon tests on pipe prepared in accordance with Victaulic specifications.
- I. Steel Pipe: Shall be steel pipe conforming to ASTM A-53 Grade "B", 1-1/2" (25-40 mm) Type F, 2-14" (50 - 600 mm) Type E or S.
1. Grooved End Pipe: Shall be grooved in accordance with Victaulic Standard Specifications.
 - a. Standard Weight Pipe shall be roll grooved or square cut grooved.
- J. Assembly: Couplings, fittings, valves and pipe shall be assembled in accordance with latest published instructions from Victaulic Company of America for the particular product installed.
1. Pipe: Shall be checked to be certain it is sufficiently free of indentations, projections, grooves, weld seams, or roll marks on the exterior of the pipe over the entire gasket seating area to assure a leak-tight seat for the gasket, that pipe ends are square cut and that preparation is in accordance with Victaulic pipe preparation standards.
 2. Gasket: All gaskets shall be of the central cavity pressure-responsive design. Gasket style and elastomeric material (grade) shall be checked to be certain gasket supplied is suited for the intended service.
 3. Lubrication shall always be used for proper coupling/fitting assembly as follows:

- a. Thorough lubrication of the gasket exterior including the lips and/or pipe ends and housing interiors, is essential to prevent pinching the gasket. Lubrication assists proper gasket seating and alignment during installation.
 - b. Use Victaulic Lubricant for installation. Other compatible materials such as silicone and others may be used; however, petroleum-based lubricants must not be used on Grade "E" or "M" gaskets.
 - c. A thin coat of Victaulic lubricant shall be applied by brush or by hand by: 1) brushing on the gasket lips (ID) and the entire exterior of the gasket; 2) brushing lubricant on the pipe ends around the entire pipe circumference and inside the coupling housing.
4. The coupling manufacturer's factory trained representative shall provide on-site training for the contractor's field personnel in the use of grooving tools, installation of product and visual inspection of properly installed couplings. The representative shall periodically visit the job site to ensure best practices in grooved product installation are being followed. (A distributor's representative is not considered qualified to conduct the training.)

K. Support:

1. The requirements of MSS-SP-69 "Pipe Hangers and Supports"- Selection and Application: shall, in general, govern the installation of hangers and supports, in accordance with the following recommendations:
 - a. Piping joined with grooved type couplings, like all other piping systems, requires support to carry the weight of pipes and equipment. Like all other methods of jointing pipes, the support or hanging method must be such as to eliminate undue stresses on joints, piping and other components. Additionally, the method of support must be such as to allow movement of pipes where required and to provide for other special requirements such as drainage, etc., as may be required by the designer. The support system for mechanical grooved type pipe couplings must consider some of the special requirements of these couplings.
2. Victaulic Floor-Mounted Riser Anchor: Engineers pipe anchor, sizes 2" through 12" to assist in directing pipe movement in piping system risers that are designed and installed with approved Victaulic products. Standard weight carbon steel to ASTM A53 with orange enamel coating with carbon steel brackets. Victaulic Original-Groove System grooved ends. Anchors suitable for system operating pressure to 500 psi. Basis of Design: Victaulic No. A10.

OR

2.3 GROOVED END PIPE

- A. Couplings, fittings, valves and other grooved components may be used as a proprietary piping method, or listed as an option to welding, threaded or flanged piping methods.
- B. Grooved Piping products shall comply with ISO 9001 Certified standards. Grooved piping installation shall meet ANSI B-31.1 – ANSI B-31.9 standards for horizontal and vertical pipe support design criteria. Grooved products shall meet national and local piping and/or building codes. Grooved products shall conform to ASTM, ANSI Standards, and other applicable Product Piping standard. All mechanical commercial and industrial piping products shall have a minimum 300 psi working pressure with 3 to 1 or greater safety working pressure.
- C. Couplings and grooved flange adapters shall conform to ASTM A-536 Ductile Grade 65-45-12 or to ASTM A-47 malleable grade 32510. Coupling track head bolts shall conform to ASTM A-183 Grade 2. Hex nuts shall conform to ASTM A-563 Grade A. Bolts and nuts are zinc electroplated. Fittings shall conform to cast ductile ASTM A-536 or cast malleable ASTM A-47. Forged steel fittings shall conform to ASTM A-234 or A-106 Gr B. Segmental welded fittings shall conform to ASTM A-53. Coatings shall be standard (orange) Alkyd-enamel rust inhibiting lead-free paint. Hot dipped galvanized fittings shall conform to ASTM A-153. Standard coupling gaskets for building

services shall be Grade “E” EPDM conforming to ASTM D-2000 with operating temperature range from -30°F to +230°F.

- D. Coupling gaskets shall be lubricated with approved lubricant as provided by the piping system manufacturer. “Extreme Temperature Lubricant” shall be used for all systems below minus 20°F, and above 180°F and systems subject to continuous cycle temperature.
- E. Black steel pipe conforming to ASTM A-53, Grade A or B, Standard Schedule 40 may be roll or cut grooved. Grooving must conform to Manufacturer’s Standards.
 - 1. Manufacturer’s Standard (rigid) couplings shall be used including flange adapters. Provide braided hoses or double sphere type flex connections for vibration attenuation and noise suppression at equipment locations.
 - a. Optional: Combination rigid, flexible and outlet couplings may be used for complete systems to aid in providing vibration, noise suppression and seismic tremor. Clamp type couplings may be used for branch outlets. Grade “E” EPDM gaskets. Flexible or other style couplings designed for axial motion or other movements must be engineered and supported in strict accordance with factory recommendations.
 - 2. Transition flange adapter from flange to groove shall conform to ANSI class 125 or 150 lb. bolt pattern. Sizes 2” – 20” 300 psig. Sizes 24” 250 psig. Style 7013 2” – 12” available for ANSI Class 250/or 300 lb. bolt pattern. 750 psig. Flanges are designed with internal anti-rotation “tangs” designated as a rigid connection 2” – 12”. Series 7012 flange adapters require sealing rings when used with certain flanged products.
 - 3. Fittings shall be cast ductile, malleable, forged steel, and/or segmentally welded steel fittings. Cast ductile conforms to ASTM A-536 or ASTM A-47. Forged steel conforms to ASTM A-234. Segmentally welded conforms to ASTM A-53. Fittings shall be coated with an Alkyd-enamel non-toxic paint. Zinc electroplated fittings conform to ASTM B-633. Hot dip galvanized fittings conform to ASTM A-153. Standard Fittings are Schedule 40 or standard wall. Other fittings are schedule 80 or lightwall as specified.
 - 4. Grooved x grooved or grooved x thread insulating nipples. Inhibits the formation of a galvanic cell between dissimilar metals. Housing: Steel Tube to ASTM A513. Liner: Polypropylene to ASTM D4140. Operating temperature -40°F to +230°F. Size range is 2” – 6” diameter.
 - 5. Branch outlets shall be Clamp T Branch and Clamp T Cross with grooved or threaded outlets. Sizes 2” – 8”. Branch outlets from ½” – 4” diameter. Designated as a bolted-on positive pipe engagement branch outlet. Working pressure to 500 psi.
 - 6. Outlet couplings shall have grooved or threaded outlets. Run sizes 1-1/2” – 6”. Branch outlets from ½” – 2” diameter. Working pressure to 500 psig.
 - 7. Plain end couplings and fittings shall be Manufacturer Standard coupling and plain-end fittings to match. Size range is 2” – 8” diameter. Materials conform to ASTM A-536 and A-47. Fittings are cast or forged steel. Intended for working pressures 300 – 750 psig with factory recommended torque requirement on plain-end standard wall pipe. Fittings match coupling working pressure.
 - 8. Plain end method shall be Manufacturer’s Standard fitting. Size range is 1” – 2” diameter. Material conforms to ASTM A-126 Class A cast iron. Working pressures from 175-300 psi UL/ULC listed FM approved.
- F. Gaskets shall be Grade “E” EPDM pressure responsive design for all water and non-oily air service. EPDM gaskets are color-coded green. Material conformance to grooved industrial standards ASTM D-2000, designation 2CA615A25B24F17Z. Temperature operating range minus 30° to +230°F. Non-toxic lubricant must be used to insure non-pinching of gaskets during product installation.

“Extreme Temperature Lubricant” must be used for all system installations, below -20°F, installations above 180°F and installations that are subject to temperature cycles.

- G. Standard products shall be furnished with alkyd enamel, rust inhibiting non-toxic paint. Galvanized material conforms to ASTM A-153. Bolts and nuts are zinc electroplated to ASTM A-164.
 - H. Couplings shall be furnished with heat treated, oval neck track head bolts conforming to ASTM A-183 Grade 2. Bolts meet minimum tensile strength of 110,000 psi. Hex nuts are carbon steel conforming to ASTM A1-563 Grade A. Bolts and nuts are electroplated.
 - I. Assembly: Couplings, fittings, valves and pipe shall be assembled in accordance with latest published instructions from the piping system manufacturer for the particular product installed.
 - 1. Pipe: Shall be checked to be certain it is sufficiently free of indentations, projections, grooves, weld seams, or roll marks on the exterior of the pipe over the entire gasket seating area to assure a leak-tight seat for the gasket, that pipe ends are square cut and that preparation is in accordance with pipe manufacturer’s preparation standards.
 - 2. Gasket: All gaskets shall be of the central cavity pressure responsive design. Gasket style and elastomeric material (grade) shall be checked to be certain gasket supplied is suited for the intended service.
 - 3. Lubrication shall always be used for proper coupling/fitting assembly as follows:
 - a. Thorough lubrication of the gasket exterior including the lips and/or pipe ends and housing interiors, is essential to prevent pinching the gasket. Lubrication assists proper gasket seating and alignment during installation.
 - b. Use manufacturer’s lubricant for installation. Other compatible materials such as silicone and others may be used; however, petroleum based lubricants must not be used on Grade "E" or "M" gaskets.
 - c. A thin coat of lubricant shall be applied by brush or by hand by: 1) brushing on the gasket lips (ID) and the entire exterior of the gasket; 2) brushing lubricant on the pipe ends around the entire pipe circumference and inside the coupling housing.
 - J. Support:
 - 1. The requirements of MSS-SP-69 "Pipe Hangers and Supports"- Selection and Application: shall, in general, govern the installation of hangers and supports, in accordance with the following recommendations:
 - a. Piping joined with grooved type couplings, like all other piping systems, requires support to carry the weight of pipes and equipment. Like all other methods of jointing pipes, the support or hanging method must be such as to eliminate undue stresses on joints, piping and other components. Additionally, the method of support must be such as to allow movement of pipes where required and to provide for other special requirements such as drainage, etc., as may be required by the designer. The support system for mechanical grooved type pipe couplings must consider some of the special requirements of these couplings.
 - K. Manufacturers: Anvil Grivlok or Tyco Grinnell.
- 2.4 STRAINERS (WATER)
- A. Perforations: .033" pipe size to 2", .057" pipe size 2-1/2" to 4", 1/8" pipe size 6" and up.
 - B. Self-cleaning "Y" type screwed end up to 2 inch with machined seats with blow-off outlet, stainless steel screen, iron body.
 - C. Self-cleaning "Y" type flanged 2-1/2 inch and up, with bolted cover flange, blow-off outlet, 125 psi ANSI, brass screen.
 - D. Manufacturer: Muesco, Sarco, Hoffman Specialties, Metraflex, Armstrong, Watson McDaniel.

2.5 THERMOMETERS

- A. Separable socket, inserted into fluid flow, adjustable, hermetically sealed, red or blue indicating fluid, non-toxic, die-cast, baked enamel finish, double strength glass lens, white scale and black graduations.
- B. Scale: Heating Water - 30 deg. to 240 deg. F
Chilled Water - 0 deg. to 100 deg. F
Dual Temperature Water – 30 deg. to 240 deg. F.
- C. Manufacturer: U.S. Gauge, H.O. Trerice, Moeller, Duro, Miljoco Corp., Winter Instruments.

2.6 GAUGES

- A. Phosphor bronze bourdon tube, polypropylene case, gasketed glass crystal, aluminum dial, black graduations 4-1/2 inch diameter.
- B. Range: 0 to 60 psi, 5-pound intervals, 1/2-pound graduations.
- C. Install with bronze gauge cock.
- D. Manufacturers: Danton, U.S. Gauge, H.O. Trerice, Moeller, Miljoco Corp., Winter Instruments, Weksler Instruments.

2.7 TEST STATIONS – PRESSURE/TEMPERATURE

- A. Provide a SISCO 1/4" or 1/2" NPT fitting (Test Plug) of solid brass at desired indicated locations. Test plug shall be capable of receiving either a pressure or temperature probe 1/8" o.d. Dual seal core shall be neoprene for temperature to 200 degrees F. Nordel to 350 degrees F and shall be rated zero leakage from vacuum to 1000 psig. P/T plug to have grooved cap and chain.
- B. P/T plugs shall be provided with extensions as required by insulation.
- C. Mechanical Contractor shall also provide the following: pressure gauge adapters with 1/8" o.d. probe, 5" stem pocket testing thermometers for 25° to 125° F (tower and chilled water) for 0° to 220° F (hot water) for 50° - 500° F (temperatures above 220° F).
- D. One (1) Master Test Kit shall be furnished to the Owners. Kit shall contain one (1) 2-1/2" test gauge of suitable range, one (1) Gauge Adapter 1/8" o.d. probe, and 5" stem pocket testing thermometers - one (1) 0° - 220° F and one (1) 50° - 550° F.
- E. Manufacturer: Sisco P/T Plugs.

2.8 ISOLATING FITTINGS

- A. Provide isolating fittings between all sections of dissimilar piping materials or piping and equipment where one material is ferrous and the other is non-ferrous.
- B. Manufacturer: Epco Sales, Inc., or insulated unions by Central Plastic Co.

2.9 PIPE SADDLES

- A. Steel pipe saddles shall be welded to all black ferrous pipe, 2-1/2" pipe size and larger, at hanger locations, for systems of hot water and other heat conveying systems.
- B. Steel pipe saddles shall be welded to all black ferrous hot piping at the pipe support location when roll type hangers or pipe roll supports are employed.
- C. The saddles shall be packed with plastic insulating cement, and the saddle shall finish flush with the surface of the specified insulation.

2.10 ANCHORS AND GUIDES

- A. Anchors and guides shall be provided to support and maintain pipes in position and properly distribute expansion. The anchors and guides must be securely fastened to the building structure, and must be completely installed before the system is tested.
- B. Factory made cast semi-steel or fabricated steel, consisting of a bolted two-section outer cylinder and base with two-section guiding spider bolted or welded tight to the pipe. Finish: Hot-dip galvanized per ASTM A-123.
- C. Guide and spider shall be of sufficient size to clear pipe insulation and long enough to prevent over travel of spider and cylinder. Guides shall not be used as pipe supports.
- D. Guides shall be 2" pre-insulated type. Insulation shall be calcium silicate insulation that is water and vapor resistant. Insulation shall be 450 PSI compressive strength per ASTM C656, Type II, Grade 5 with a K-Factor of 0.62 @ 400 deg. F in accordance to ASTM C-518. Insulation shall meet ASTM E-84 for Flame Spread/Smoke Development standards.
- E. Guides shall be as manufactured by J.J. McNally, Inc., Metraflex, Hyspan, Twin City Hose, Inc., National Pipe Hanger Corp.

2.11 FLEXIBLE EXPANSION LOOP (MANUFACTURED)

- A. Provide flexible expansion loops of size and type noted on drawings.
- B. Flexible expansion loops shall consist of two (2) flexible sections of hose and braid, two 90° elbows, and a 180° return assembled in such a way that the piping does not change direction, but maintains its course along with a single axis.
- C. Flexible expansion loops shall have a factory supplied, center support nut located at the bottom of the 180° return, and a drain/air release plug.
- D. Flexible expansion loops shall impart no thrust loads to system support anchors or building structure. Loops shall be installed in a neutral, pre-compressed or pre-extended condition as required for the application. Install and guide per manufacturer's recommendations.
- E. Materials of construction and end fitting type shall be consistent with pipe material and equipment/pipe connection fittings.
- F. Manufacturers: Metraflex Company, Metraloop.

OR

- A. Provide flexible expansion loops of size and type noted on drawings.
- B. Construction shall be three (3) equal length sections of annular corrugated 321 stainless steel close-pitch hose with stainless steel overbraid which will absorb or compensate for pipe movements in all six degrees of freedom (three coordinate axes, plus rotation about those axes) simultaneously.
- C. The corrugated metal hose, braid(s), and a stainless-steel ring-ferrule/band (material gauge not less than .048") must be integrally seal-welded using a 100% circumferential, full-penetration TIG weld. End fittings shall be flat-face plate steel flanges with 150# ANSI drilling and outside diameter. Fittings must be attached using a 100% circumferential TIG weld.
- D. Braided stainless steel loops must be suitable for operating temperatures up to 850°F, must be designed for pressure testing to 1.5 times their maximum rated working pressure and a minimum 4:1 (burst to working) safety factor.
- E. Each braided stainless steel loop shall be individually leak tested by the manufacturer using air-under-water or hydrostatic pressure. Loops shall be prepared for shipment using a cut-to-length metal shipping bar, tacked securely between the elbows of the two parallel legs, to maintain the manufactured length during shipping. Shipping bar must be removed prior to system start up.

- F. Braided loops will be covered by three (3) year full replacement warranty when installed in accordance with all specifications and installation instructions as described in the manufacturer's Installation and Maintenance Instructions.
- G. End fittings shall be consistent with pipe material and equipment/pipe connection fittings.
- H. Manufacturers: Flex Hose Co. Tri-Flex Loop.

2.12 UNIONS

- A. Up to and including 2-inch pipe size: Screwed pattern, bronze-to- bronze seat.
- B. Above 2-inch pipe size: Flanged pattern, A.S.A. forged steel, with gaskets, bolts and nuts.
- C. Copper tubing unions shall have sweated type ends. Flanged unions on copper tubing may be soldered connections.
- D. Materials and pressure ratings shall be the same as specified for the respective pipe and fitting system unless otherwise specified.

2.13 MOTORS

- A. All single phase and polyphase motors shall be manufactured to incorporate the latest NEMA standards.
- B. All single phase and polyphase motors shall have steel frames with ball bearings and copper windings. All motors to have a Class "F" insulation system with a service factor of 1.15.
- C. All motors shall be 1725 RPM, 4 pole design, unless otherwise noted on the drawings, or in the equipment specifications.
- D. Motors installed indoors and not exposed to moisture shall be open, dripproof, Class B temperature rise based on 40 deg. C maximum ambient temperature.
- E. Motors installed outdoors and exposed to moisture shall be totally enclosed, fan cooled, Class B temperature rise based on 40 deg. C maximum ambient temperature.
- F. Based on NEMA Standards, motors shall comply with the following minimum nominal efficiencies at full load.

Nominal Efficiencies for "NEMA Premium TM" Induction Motors Rated 600 Volts or Less (Random Wound)						
	Open Drip-Proof			Totally Enclosed Fan-Cooled		
HP	3500 RPM	1800 RPM	1200 RPM	3500 RPM	1800 RPM	1200 RPM
1	82.5	85.5	77.0	82.5	85.5	77.0
1.5	86.5	86.5	84.0	87.5	86.5	84.0
2	87.5	86.5	85.5	88.5	86.5	85.5
3	88.5	89.5	85.5	89.5	89.5	86.5
5	89.5	89.5	86.5	89.5	89.5	88.5
7.5	90.2	91.0	88.5	91.0	91.7	89.5
10	91.7	91.7	89.5	91.0	91.7	90.2
15	91.7	93.0	90.2	91.7	92.4	91.0
20	92.4	93.0	91.0	91.7	93.0	91.0
25	93.0	93.6	91.7	93.0	93.6	91.7
30	93.6	94.1	91.7	93.0	93.6	91.7

- G. Motor Characteristics: Refer to Equipment Schedules for specific data.
277/480 Volt System: Motors 1/2HP & Larger - 480V, 3 Phase, 3 Wire
Motors Less than 1/2HP-120/277V, 1 Phase, 2 Wire.
- H. All motors rated less than 1/2HP shall have thermal protection of the auto-reset type as an integral part of the motor.
- I. All motors rated 1/2HP and larger shall have thermal protection provided by an external device.
- J. Whenever a variable frequency PWM drive is installed to control an AC motor, a maintenance-free, circumferential, conductive micro fiber shaft grounding ring shall be installed on the AC motor drive end to discharge shaft currents to ground. Recommended part: AEGIS SGR™ Bearing Protection Ring, as made by Electro Static Technology. Install in accordance with the manufacturer's written instructions.

PART 3 – EXECUTION

3.1 PIPING SYSTEMS

- A. All piping to drain to low points. Low points shall be provided with drain valves with hose thread.
- B. All piping shall be arranged to have air vents at high points. Indicate locations on submittals and as-builts.
 - 1. Air vents shall be automatic in operation when located in Mechanical Equipment Rooms. All air vents shall be provided with a PVC drain line which shall be routed to the nearest floor drain. Several air vents may be tied together.
 - 2. Air vents shall be manual in operation in all other locations.
- C. Do not install trapped lines where water cannot be drained or air can accumulate without being vented.
- D. Piping shall run square with building lines.
- E. Piping shall not be insulated or covered until tested and until building is enclosed.
- F. Necessary drains, off-sets, vents and drips shall be provided for coordination of the work as part of the contract.
- G. Running or close nipples are not permitted.
- H. Piping shall not be installed over electrical transformers, panels, switchgear, substations, and control panels. No piping shall be installed in elevator machine rooms.
- I. Exposed insulated piping risers in unfinished spaces shall be covered with 22-gauge galvanized steel sleeves from floor to ceiling. Refer to Section: Insulation & Covering – HVAC for additional requirements.
- J. Allow clearance for expansion and contraction.
- K. Install eccentric piping fittings where change in sizes occurs in piping systems. Tops of pipes shall remain level for hydronic systems.
- L. Install isolating fittings between sections of ferrous and non-ferrous pipe or connected equipment.
- M. Do not support piping from other piping, conduits or equipment.
- N. Support Piping from building structure with expansion bolts, rods, steel angles or channels installed to meet existing or new building conditions.
- O. Drilling into the roof deck is not permitted.
- P. Strainers shall be installed on suction of all pumps, inlets of control valves, and where indicated on drawings.

- Q. Thermometers and gauges shall be installed where indicated on the drawings, required by equipment specifications and where indicated elsewhere in the specifications.
 - R. Flexible connectors shall be provided on suction and discharge piping of all base mounted pumps.
 - S. Unions shall be provided adjacent to all valves, at equipment connections, and where necessary to facilitate dismantling of the piping system.
 - T. Install expansion loops, anchors and guides in piping systems as shown on the drawings and in accordance with manufacturer's written instructions.
 - 1. Remove all shipping blocks, stays, setscrews, etc., from all loops and moment guides. Pipe centerlines shall be aligned.
 - 2. During initial system pressurization, all pipe guides and anchors must be secure and functioning.
 - U. Material Requirements for Systems:
 - 1. Heating Hot Water Supply & Return Piping:
 - a. Schedule 40 black steel.
 - b. Type L hard copper.
 - c. Grooved End black steel (Only permitted in Penthouse)
 - 2. Chilled Water Supply & Return Piping:
 - a. Schedule 40 black steel.
 - b. Type L hard copper.
 - c. Grooved End black steel (Only permitted in Penthouse and out to Chiller)
 - 3. Make-up Water: Type L hard copper.
 - 4. Dual Temperature Water Supply & Return Piping:
 - a. Schedule 40 black steel.
 - b. Type L hard copper.
 - c. Grooved End black steel (Only permitted in Penthouse)
 - 5. AC Condensate Drain (including pumped condensate):
 - a. Type DWV copper.
 - 6. Refrigerant Piping: Type ACR hard copper.
- 3.2 TAGS, CHARTS AND IDENTIFICATION
- A. See Paragraph "Labeling" in GENERAL PROVISIONS for equipment labeling.
 - B. Identify each valve in all systems with black, numbered and stamped 1 - 1/2" brass or aluminum tags fastened to valve by brass chain and S-hook.
 - C. Provide 1/8" scale diagrams showing location, number and service or function of each tagged item.
 - 1. Frame diagrams in approved metal frames with clear acrylic front, hinges, and locks.
 - 2. Secure to wall in Mechanical Room.
 - 3. Provide two additional separate copies permanently covered and bound.
 - a. Include one (1) copy in the Operation and Maintenance Manuals.
 - D. Piping Identification: Identify piping with Seton "Setmark" or Brimar, semi-rigid plastic, wraparound pipe markers with flow arrows and conforming to ANSI A13.1. Locate marker at each valve, changes in direction, where pipes pass thru barriers and every 25' of horizontal runs. Lettering on background shall be in accordance with the following colors:

Legend		Background	Lettering
1.	Chilled Water Supply	- Green	- White
2.	Chilled Water Return	- Green	- White
3.	Gas	- Yellow	- Black
4.	Heating Water Supply	- Yellow	- Black
5.	Heating Water Return	- Yellow	- Black
6.	Dual Temperature Water Supply	- Yellow	- Black
7.	Dual Temperature Water Return	- Yellow	- Black
8.	Refrigerant Liquid	- Yellow	- Black
9.	Refrigerant Gas	- Yellow	- Black
10.	Cold Water Make-up	- Green	- White
11.	Vent	- Yellow	- Black

- E. Provide color coded 1" diameter markers on ceiling tile grids to indicate system and valve locations.

Chilled Water: - Blue

Hot Water: - Red

Dual Temperature Water: - Red

- F. Manufacturers: Seton "Setmark", Brimar, B-Line MSI.

3.3 WELDING

- A. All concealed and inaccessible black steel piping shall be welded.
- B. All black steel piping larger than 1-1/4 inch may be fusion welded.
- C. All elbows, tees and branch connections shall be made with welding fittings ANSI B16.9.
- D. Welding shall be in accordance with the ASME Boiler and Pressure Vessel Code Section IX.
- E. Furnish welder test certificate for review. Certificates of successful qualification by the following organizations shall be acceptable.
 1. ASME Boiler and Pressure Vessel Code
 2. ANSI Code for Pressure Piping
 3. National Certified Pipe Welding Bureau
 4. Military Specification MIL-STD-248

3.4 SOLDERING/BRAZING

- A. Connections between copper tubing and copper fittings shall be made with the appropriate filler metal. Flux shall be non-corrosive type as recommended by the manufacturer of the filler metal, and conforming to AWS A5.8.
- B. Tubing shall be cut square and then reamed and deburred. End of tubing and inside of fitting cup shall be cleaned with steel wool and the flux shall be applied to the clean surface before joining. After joining, the excess filler metal shall be wiped off while still plastic.
- C. Silver brazing alloy shall be equal to Easy-Flo by Handy and Harmon or Sta-Brite silver solder and shall be used for joints in:
 1. Hot water heating piping
 2. Chilled water piping

3. Air conditioning condensate drain piping
 4. Dual temperature water piping
 5. Cold water fill and make-up piping
- D. Where the silver brazing is performed in a confined non-ventilated space, a non-toxic, cadmium-free brazing alloy such as braze 560 by Handy & Harman shall be used.
 - E. Refrigerant piping shall be silver brazed using Harris Sil-Fos 15 or equivalent, with nitrogen purge.
 - F. Bring joint to solder temperature or brazing temperature in as short a time as possible.
 - G. Form continuous solder bead or brazing filler bead around entire circumference of joint.
 - H. Wipe excess solder from joint area while solder is still plastic.

END OF SECTION

SECTION 23 02 15

VALVES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary and other conditions, if any) and Division 1 as appropriate, apply to the work specified in this section.
- B. Refer to Section 230200 for HVAC General Provisions.
- C. Refer to other sections in Division 23 for materials and methods not specified herein.

1.2 DESCRIPTION OF WORK

- A. This Section includes the following:
 - 1. General
 - 2. Chilled Water Systems
 - 3. Hot Water Heating System and Dual Temperature System
 - 4. Refrigerant Valves and Specialties
 - 5. Grooved End Specialties

1.3 QUALITY ASSURANCE

- A. Provide adequate supervision of labor force to assure that all aspects of the specifications are being fulfilled.
- B. Verify that all work and equipment is installed in accordance with manufacturer's warranty requirements.

PART 2 – PRODUCTS

2.1 GENERAL

- A. All gate and globe valves shall be designed for repacking under pressure when fully opened, and shall be equipped with packing suitable for the intended service. When the valve is fully opened, the back seat shall protect the packing and the stem threads from the fluid. All gate and globe valves shall have a gland follower. The pressure- temperature rating of valves shall be not less than the design criteria applicable to all components of the system.
- B. Insofar as possible, all valves of the same type shall be of the same manufacture.
- C. Valves installed above 7 ft. in Mechanical Rooms shall have chain operators.
- D. All valves shall be provided with stem extensions. Valve handle shall be clear of insulation jacket.
- E. Manufacturers:
 - Stockham
 - Milwaukee
 - Hammond
 - Apollo
 - Watts
 - Walworth
 - Nibco
 - Jamesbury

2.2 CHILLED WATER SYSTEMS

A. Gate Valves - 2" and smaller:

Valves 2" and smaller shall be of Class 125, body and bonnet shall be of ASTM-B-62 cast bronze composition, threaded or solder ends, solid disc, copper-silicon alloy stem, brass packing gland, Teflon- impregnated packing and malleable handwheel.

Recommended Valves:

Threaded:	Solder:
Stockham B-100 (RS)	Stockham B-108 (RS)
or	or
Stockham B-103 (NRS)	Stockham B-104 (NRS)
RS NRS	RS NRS

Hammond IB690	IB609	Nibco	S111	S113
Milwaukee 148	105	Hammond	IB691	IB613

B. Gate Valves - 2-1/2" and Larger:

Valves 2-1/2" and larger shall be Class 125 iron body, bronze mounted, with body and bonnet conforming to ASTM A-126 Class B cast iron, flanged ends with Teflon-impregnated packing and two-piece packing gland assembly.

Recommended valves:

Stockham G-623 OS&Y	RS
Stockham G-612	NRS
	OS&Y NRS
Hammond	IR1140 ---
Nibco	F617-0 F639-31

C. Ball Valves - 3" and Smaller:

Valves 3" and smaller shall be 600 psi CWP, have cast brass bodies, replaceable reinforced Teflon seats, conventional port, blowout proof stems, chrome plated brass ball, and threaded or solder ends. Provide extended valve handle to accommodate up to 2" of insulation with non-thermal conductive material, insulation plug, cap and protective sleeve.

Recommended valves:

Threaded:	Solder:
Stockham S-216-BR-RT	Stockham S-216-BR-RS
NIBCO T-580-70BR	NIBCO S-580-70BR-R
Jamesbury II 1100TT	----
Apollo 70-100	Apollo 70-200
Inline 334	----

Alternative is Stockham S-217-BR-RT (threaded).

Drain valves, 1/2" or 3/4" shall be 600 psi CWP, with stainless steel trim, cast bronze body, 2-piece with cap and chain, full port stainless steel ball and stem, RTFE ball seat, threaded or soldered inlet connection, cap rated for 150 psi.

Recommended valve:

Stockham S-285-BR-R-66-HC.

D. Globe Valves - 2" and Smaller:

Valves 2" and smaller shall be of Class 125, body and bonnet of ASTM B-62 cast bronze composition, threaded or soldered ends, copper silicon alloy stem, brass packing gland, Teflon-impregnated packing, and malleable handwheel.

Recommended valves:

Threaded:	Solder:
Stockham B-13T	Stockham B-14T
(Teflon Disc)	(Teflon Disc)
Stockham B-16	Stockham B-17
(Bronze Disc)	(Bronze Disc)
Nibco T211B	Jenkins 1200
Hammond IB440	Nibco S211Y

E. Globe Valves - 2-1/2" and Larger:

Valves 2-1/2" and larger shall be Class 125 iron body, bronze mounted with body and bonnet conforming to ASTM A-126 Class B cast iron, flanged ends, with Teflon-impregnated packing and two-piece packing gland assembly.

Recommended valves:

Stockham G-512 (Bronze disc)	
Stockham G-514T (Teflon disc)	
Bronze Disc:	Comp. Disc.:
Hammond IR116	---
Nibco F718B	---

F. Butterfly Valves - 2-1/2" and Larger: (Chilled Water)

Valves 2-1/2" and larger shall be high performance, bubble-tight, lug-wafer type body or grooved-end, 200 psi CWP, conforming to ASTM A-126 Class B cast iron, drilled and tapped, field replaceable EPDM sleeve, with ductile nickel-plated disc, 410 stainless steel stem, and EPDM O-ring stem seals. Sizes 2 - 6" shall be lever operated and 8 - 24" shall have gear operators.

Recommended valves:

Stockham LG-712-DS3-E	Lever operated
Stockham LG-722-DS3-E	Gear operated
Victaulic 300 Masterseal and AGS VIC300-grooved-end	
Lever:	Gear:
Demco NE-150-5215351	NE-150-5215359-2097
Norris R3020-13SS-1F	R3010-13SS-2K
Keystone Fig. 129	129
Center Line Series LT	Series LT
Grinnell LC8201-1	LC8202-1

Alternative for above is Stockham LD-712-DS3-E and LD-722-DS3-E ductile iron body butterfly valves (ASTM A-395 Ductile).

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

G. Check Valves - 2" and Smaller:

Valves 2" and smaller shall be of Class 125, threaded or solder ends, body and caps shall be ASTM B-62 cast bronze composition, swing type disc.

Recommended valves:

Threaded:	Solder:
Stockham B-319	Stockham B-309
Hammond IB490	IB941
Milwaukee 509	1509

If composition disc is preferred, specify Stockham B-320B - threaded end, or B-310B - solder end, for Class 125 service.

H. Check Valves - 2-1/2" and Larger:

Valves 2-1/2" and larger shall be iron body, bronze mounted with body and cap conforming to ASTM A-126 Class B cast iron, flanged or grooved ends, swing type disc.

Recommended valves:

Stockham G-931
Hammond IR1124
Milwaukee F2974
Victaulic 716, 779, or W715 – Grooved end

2.3 HOT WATER HEATING SYSTEM AND DUAL TEMPERATURE SYSTEM

A. Gate Valves - 2" and smaller:

Valves 2" and smaller shall be of Class 150 with body and union bonnet of ASTM B-62 cast bronze composition, threaded or solder ends, solid disc, copper-silicon stem, brass packing gland, Teflon- impregnated packing, and malleable handwheel.

Recommended valves:

Threaded:	Solder:
Stockham B-120 (RS)	Stockham B-124
Stockham B-130 (RS)	----
Hammond IB629	IB648
Nibco T134	S134

B. Ball Valves - 3" and smaller:

Valves 3" and smaller shall be 600 psi CWP, have cast brass bodies, replaceable reinforced Teflon seats, conventional port, blowout proof stems, chrome plated brass ball, and threaded or solder ends with extended solder cups. Provide extended valve handle to accommodate up to 2" of insulation with non-thermal conductive material, insulation plug, cap and protective sleeve.

Recommended valves:

Threaded:	Solder:
Stockham S-216-BR-RT	Stockham S-216-BR-RS

Worcester 4112 RT	---
Jamesbury II 1100TT	----
Apollo 70-100	Apollo 70-200
Nibco T580-70BR	S580-70BR-R
Inline 334	----

Drain valves, ½" or ¾", shall be 600 psi CWP, with stainless steel trim, cast bronze body, 2-piece with cap and chain, full port stainless steel ball and stem, RTFE ball seat, threaded or soldered inlet connection, cap rated for 150 psi.

Recommended valve:

Stockham S-285-BR-R-66-HC

C. Gate Valves - 2-1/2" and larger:

Valves 2-1/2" and larger shall be Class 125 iron body, bronze mounted, with body and bonnet conforming to ASTM A-126 Class B cast iron, flanged ends, with Teflon-impregnated packing and two-piece packing gland assembly.

Recommended valves:

Stockham G-623 (OS&Y) RS

Stockham G-612 (NRS)

	OS&Y	NRS
Nibco	F618-0	F639-31
Hammond IR1140		

D. Globe Valves - 2" and smaller:

Valves 2" and smaller shall be of Class 150 with body and union bonnet of ASTM B-62 bronze, copper-silicon alloy stem, brass packing gland, Teflon-impregnated packing and malleable handwheel.

Recommended valves:

Threaded:	Solder:
Stockham B-22 (Teflon Disc)	Stockham B-24 (Teflon Disc)
Stockham B-29 (Stainless trim) ----	
Comp. Disc.:	S.S. Trim:
Nibco T-235-Y	Milwaukee 591A

E. Globe Valves - 2-1/2" and Larger:

Valves 2-1/2" and larger shall be Class 125 body, bronze mounted, with body and bonnet conforming to ASTM A-126 Class B cast iron, flanged ends, with Teflon - impregnated packing and two-piece packing gland assembly.

Recommended valves:

Stockham G-512 (bronze disc)

Stockham G-514 (Teflon disc)

Hammond IR 116

Nibco F7181B

F. Butterfly Valves - 2-1/2" and Larger:

Valves 2-1/2" and larger shall be high performance, bubble-tight, lug-wafer type body or grooved-end, 200 psi CWP, conforming to ASTM A-126 Class B cast iron, drilled and tapped, replaceable EPDM sleeve, with ductile nickel-plated disc, 410 stainless steel stem, and EPDM O-ring stem seals. Sizes 2 - 6" shall have lever operators and 8 - 24" shall have gear operators.

Recommended valves:

Stockham LG-712-DS3-E Lever operated

Stockham LG-722-DS3-E Gear operated

Victaulic 300 Masterseal and AGS VIC300 – Grooved end

Lever:

Gear:

Demco NE-150-5215351 NE-150-5215359-2097

Norris R3010-13SS-1F R3010-13SS-2K

Keystone Fig. 129 129

Center Line Series LT Series LT

Grinnell LC8201-1 LC 8202-1

TREATED SYSTEM:

Recommended Valves:

Stockham LG-712-BS3-E Lever operated

Stockham LG-722-BS3-E Gear operated

Victaulic 300 Masterseal and AGS VIC300 – Grooved end

Alternative for above is Stockham Ductile Iron Butterfly Valves conforming to ASTM-A-395 ductile iron.

Ductile Valves:

Stockham LD-512-DS3-E or LD-512-BS3-E
(lever operated-wafer body)

Stockham LD-522-DS3-E or LD-512-BS3-E
(gear operated-wafer body)

Stockham LD-712-DS3-E or LD-712-BS3-E
(lever operated-lug body)

Stockham LD-722-DS3-E or LD-712-BS3-E
(gear operated-lug body)

Note: Butterfly valves in dead end service require both upstream and downstream flanges for proper shutoff and retention.

G. Check Valves - 2" and smaller:

Valves 2" and smaller shall be Class 150 with bodies and caps of ASTM B-62 bronze composition and threaded ends. Class 150 valves shall have lift-type Buna-N-disc and union caps, and are to be used in lines with globe valves.

Recommended valves:

Stockham B-322-B

Hammond IB948

Milwaukee 510

For backflow prevention in lines with gate valves, Y-pattern valves with swing-type disc are recommended.

For Class 150 Service, threaded ends:

Stockham B-321

H. Check Valves - 2-1/2" and Larger:

Valves 2" and larger shall be iron body, bronze mounted, with body and cap conforming to ASTM A-126 Class B cast iron, flanged or grooved ends, and swing-type disc.

Recommended valves:

Stockham G-931

Hammond IR1124

Nibco F918-B

Victaulic 716, 779, or W715 – Grooved end

2.4 REFRIGERANT VALVES & SPECIALTIES

A. Service Valves:

1. Globe Shutoff Valves: Forged brass, packed, back seating, winged seal cap, 300 degrees F (149 degrees C) temperature rating, 500 psi working pressure.
2. Check Valves: Forged brass, accessible internal parts, soft synthetic seat, fully guided brass piston and stainless-steel spring, 250 degrees F (121 degrees C) temperature rating, 500 psi working pressure.
3. Manufacturers:
Henry Valve Co.
Parker Hannifin Corp., Refrigeration & Air-Conditioning
Sporlan Valve Co.

B. Solenoid Valves:

1. 2-way Solenoid Valves: Forged brass, designed to conform to ARI 760, normally closed, teflon valve seat, NEMA 1 solenoid enclosure, 24-volt, 60 Hz., UL-listed, 1/2" conduit adapter, 250 degrees F (121 degrees C) temperature rating, 400 psi working pressure.
2. Manufacturers:
Alco Controls Div., Emerson Electric Co.
Automatic Switch Co.
Sporland Valve Co.

C. Specialties:

1. Refrigerant Strainers: Brass shell and end connections, brazed joints, monel screen, 100 mesh, UL listed, 350 psi working pressure.
2. Moisture-Liquid Indicators: Forged brass, single port, removable cap, polished optical glass, solder connections, UL listed, 200 degrees F (93 degrees C) temperature rating, 500 psi working pressure.
3. Refrigerant Filter-Driers: Steel shell, ceramic fired desiccant core, solder connections, UL listed, 500 psi working pressure.

4. Evaporator Pressure Regulators: Provide corrosion-resistant, spring loaded, stainless steel springs, pressure operated, evaporator pressure regulator, in size and working pressure indicated, with copper connections.
5. Refrigerant Discharge Line Mufflers: Provide discharge line mufflers as recommended by equipment manufacturer for use in service indicated, UL listed.
6. Manufacturers:
Alco Controls Div., Emerson Electric Co.
Henry Valve Co.
Parker-Hannifin corp., Refrigeration & Air Conditioning Div.
Sporlan Valve Co.

2.5 GROOVED-END SPECIALTIES

A. Strainers

1. T-Type Strainer: 2" and larger sizes, 300 PSI (2065 kPa) T-Type Strainer shall consist of ductile iron (ASTM A-536, Grade 65-45-12) or carbon steel (ASTM A-53) body, Type 304 stainless steel frame and mesh removable basket with No. 12 mesh, 2"-3" strainer sizes, or No. 6 mesh, 4"-16" strainer sizes, 57% free open area. Victaulic Style 730. For 14" through 24", use T-Type W730 AGS with stainless steel removable basket.
2. Y-Type Strainer: 2" through 12" sizes, 300 PSI (2065 kPa) Y-Type Strainer shall consist of ductile iron body, ASTM A-536, Grade 65-45-12, Type 304 stainless steel perforated metal removable baskets with 1/16" (1.6mm) diameter perforations and 41% open area 2"-3" strainer sizes or 1/8" (3.2mm) strainer sizes diameter perforations and 40% open area 4"-12" strainer sizes. Victaulic Style 732.

- B. Suction Diffuser – Grooved/Flanged End. Rated to 300 psi (2065kPa). Ductile iron (ASTM A-536) body. 304 stainless steel frame and perforated sheet diffuser with 5/32" (4.0mm) diameter holes 3"-12" inlet sizes or 3/16" (4.8mm) diameter holes 14" and 16" inlet sizes. Removable 20 mesh 304 stainless steel start-up prefilter, outlets for pressure/temperature drain connections, and base supports boss. Victaulic Series 731-G. For sizes 14" through 24", use W731G AGS.

PART 3 – EXECUTION

3.1 PIPING SYSTEMS

- A. All piping to drain to low points. Low points shall be provided with drain valves with hose thread.
- B. Valve body construction shall match piping system material.
- C. Install isolating fittings between sections of ferrous and non-ferrous pipe or connected equipment.
- D. Valves shall be installed with stems above horizontal.
- E. Valves shall be installed on all sides of equipment and control valves to allow isolation for repair.
- F. Unions shall be provided adjacent to all valves, at equipment connections, and where necessary to facilitate dismantling of the piping system.
- G. Provide adequate runs of straight pipe on both sides of a balancing valve, as per manufacturer's recommendations.

3.2 TAGS, CHARTS AND IDENTIFICATION

- A. Identify each valve in all systems in accordance with requirements of Section 230210.

END OF SECTION

SECTION 23 02 30
INSULATION & COVERING – HVAC

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the contract, including the conditions of the contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the work specified in this section.
- B. Refer to Section 230200 for HVAC General Provisions
- C. Refer to Section 230210 for HVAC Basic Materials & Methods.

1.2 DESCRIPTION OF WORK

- A. This Section includes insulation and covering provided on the following piping and equipment:
 - 1. Cold Water Make-Up Piping
 - 2. Hot Water Heating Piping
 - 3. Chilled Water Piping
 - 4. Condensate Drain Lines
 - 5. Dual temperature water piping.
 - 6. Refrigerant Piping.
 - 7. Cold Equipment Surface
 - 8. Hot equipment surfaces.
 - 9. Acoustic Duct Liner
 - 10. Reusable Valve Covers
 - 11. Insulated Pipe Saddles
- B. Insulation shall be installed on the following duct systems:
 - 1. All supply ductwork.
 - 2. All return and transfer ductwork.
 - 3. All outside air intake and relief ductwork.
 - 4. All ductwork connected to energy recovery units.

1.3 REFERENCE STANDARDS

- A. Refer to Section 230200 for a general description of requirements applying to this section.

1.4 QUALITY ASSURANCE

- A. Refer to Section 230210 for a general description of requirements applying to this section.
- B. Install insulation in accordance with manufacturer's recommendations.
- C. Provide adequate supervision of labor force to assure that all aspects of the specifications are being fulfilled.

1.5 SUBMITTALS

- A. Submit shop drawings, installation instructions, and manufacturer's literature of all materials specified in accordance with Section 230200.
- B. Submit fabrication instructions for pipe fitting and valve insulation.
- C. Submit manufacturer's joining recommendations for butt joints and longitudinal seams.

1.6 WARRANTY/GUARANTEE

- A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, General Requirements.

PART 2 – PRODUCTS

2.1 PIPE INSULATION MATERIAL

A. Fiberglass:

1. Material: Preformed fiberglass bonded with resin to form circular pipe sleeves with factory applied, white all service jacket bonded to reinforced foil vapor barrier jacketing. The jacket shall have factory applied double pressure-sensitive, self-sealing, adhesive closure and vapor sealing of longitudinal joints. Thermal conductivity: 0.24 Btu/Hr./SF/inch at 100 degrees F. Flame spread of 25 and developed smoke of 50 or less.
2. All Valves and Fittings:
 - a. Glass fiber insert and pre-molded PVC cover, Johns Manville Corp. "Zeston" and "Hi-Lo Temp Inserts" for fittings. Glass fiber or prefabricated elastomeric foam fittings must fill the entire space within the cover completely.
 - b. Factory molded fibrous glass fitting covering for fittings. Coat ends with Fosters 30-36 lagfast adhesive
 - c. Mitered sections of pipe covering for valves.
3. Manufacturers: Johns Manville Corp., Certain-Teed, Owens- Corning, Knauf, Armacell.

B. Closed Cell:

1. Material: Black flexible elastomeric foamed closed cell structure insulation 25/50 rated with a flame spread rating of 25 or less and a smoke developed rating of 50 or less with both a moisture seal and a reinforced elastic foam lap seal closure system.
2. Flexible pipe insulation shall be a foamed elastomeric closed cell structure material, with a thermal conductivity of not more than 0.27 Btu/Hr./Sq. Ft./Inch at a mean temperature of 75 degrees F. The insulation shall have an average density of at least 2 pounds per cubic foot, shall be self-extinguishing, and shall have a water vapor transmission rating of not more than 0.1 perms. Between temperature limits of -40 degrees F and plus 220 degrees F, the insulation shall not indicate any deviation from its original state.
3. Specification Compliance:

ASTM-E-84

ASTM-C-534 Type I – Tubular, Type II – Sheet.

ASTM-D-1056, 2B1 – Tubular, Sheet.

MIL-C-3133B (MIL STD 670B) Grade SBE-3

MIL-P-15S280J, Form T, Form S.
4. Manufacturers: Armacell, Nomaco, K-Flex, Rubatex.

C. Covering of Pipe Insulation Outdoors:

1. Wrapping: Wrap insulation with embossed 0.016" aluminum jacket.
2. Fastenings: Cover shall be held in place with soft aluminum bands on 12" centers.
3. Valves and Fittings: Weatherproof all valves and fittings.

D. Manufacturers: Johns Manville Corp., Certain-Teed, Owens- Corning, Knauf.

2.2 DUCT INSULATION

- A. Concealed Supply, Return, Relief, and Outside Air Ductwork, and all ductwork connected to energy recovery units: Fiberglass duct wrap bonded with resins, 3/4 pound density, aluminum foil facing reinforced with fiberglass scrim, laminated to Kraft, 2" thick.
1. Thermal Conductivity: 0.27 Btu/Hr./SF/Inch at 75 degrees F. Min. installed "R" value w/25% compression shall be 5.6.
 2. Duct wrap shall be cut to stretch-out dimensions as provided in manufacturer's instructions. Remove a 2" piece of insulation from the facing at the end of the piece of insulation to form an overlapping staple and tape flap. Install with facing outside so tape flap overlaps insulation and facing at other end. Insulation shall be tightly butted and not compressed excessively at duct corners. Seams shall be stapled 6" on center with outward clinching staples. All seams, tears, punctures and other penetrations of the insulation facing shall be sealed with foil tape or vapor proof mastic. Where rectangular ducts are 24" in width or greater, duct wrap shall be secured to the bottom of the duct with mechanical fasteners; i.e., stick pins spaced 18" on center.
- B. Exposed supply, return, relief, and outside air ductwork, and all ductwork connected to energy recovery units, shall be insulated in finished conditioned spaces, penthouse, mechanical rooms, mezzanine areas, equipment closets, and non-conditioned spaces with 2" thick rigid fiberglass board. Insulation shall be 6 P.C.F. density with a "K" value of 0.25 Btu/Hr./SF/Inch at 75 degrees F. mean temperature and shall be U.L. listed at 25 maximum for flame spread, and 50 maximum for smoke developed. Insulation shall be applied using Graham Pins or Stik-Clips and all seams, edges and breaks shall be sealed with 4" matching tape and sealed with Vicryl CP-10 to match ASJ jacket. Insulation shall be provided with all-service jacket facing.
- C. Manufacturers: Johns Manville Corp., Certain-Teed or Owens- Corning, Knauf.
- D. Outdoor Installation:
1. Pre-manufacturer panel system consisting of four (4) piece, interlocking panels.
 2. The interlocking panels shall be constructed of Dow Thermax Polyisocyanurate insulation, ASTM D-1622, nominal 2 pcf; water vapor transmission as permeance less than 0.03, per ASTM E-96; water absorption less than 0.3% (24 hours), per ASTM C-209; flexure strength more than 40 psi, per ASTM C-203.
 3. Operating temperature range of -100°F to +250°F.
 4. Insulation shall be laminated in two (2) layers to provide R-14 at 2" thickness, per ASTM C-236/C-518.
 5. The insulation shall be jacketed with 0.032" thick embossed aluminum and sealed with vapor barrier compound, All joints shall interlock to ensure a thermal seal.
 6. Panels shall be secured with #10 self-tapping stainless screws with weather seal washers.
 7. Manufacturers: Techna-Duc Insulation System as made by P.T.M. Manufacturing, L.L.C., Newark, Delaware.

OR

- D. Outdoor Installation:
1. Pre-manufactured exterior duct weatherization and insulation system with a 20-year warranty.
 2. Insulation materials shall be 2-inch thick, nominal 2 PCF density with a "K" value of 0.16 Btu/Hr./SF/Inch at 75 degrees F mean temperature, laminated polyisocyanurate foam insulation encased in 1.25 mil aluminum foil. Insulation shall be jacketed with a 0.032" thick embossed aluminum jacket. Jacket shall be secured using aluminum pop-rivets and approved caulk and/or sealant. Minimum installed "R" value shall be R-13.

3. Provide duct roof pitch-supports (12-degree pitch) at all flanges, stiffeners, insulation joints along the top of the horizontal ducts with 24-inch maximum spacing.
4. Seams to be overlapped a minimum of 2 inches with a watershed application as per manufacturer's design guidelines.
5. Foil tape used for sealing the insulation shall be a minimum thickness 2.0 mil pressure sensitive tape 4" FSK tape.
6. Manufacturer: Fabrite TM as made by County Insulation Group, or an approved equal using material and jacketing with a 20-year warranty.
 - a. Approved equal shall be an insulation system constructed of glass-reinforced polyisocyanurate foam insulation encase in 1.25 mil aluminum foil vapor barrier facing. All insulation shall be a minimum thickness of 2 inch rigid or non-flexible board type, nominal 2.0 PCF density with a "K" value of 0.16 Btu/Hr/SF/Inch at 75 degrees F mean temperature. All seams shall be sealed with foil tape. Insulation shall be jacketed with a 0.032" thick embossed aluminum jacketing and adhered to insulation foil facing. Jacketing shall be overlapped and pitched to shed water to avoid standing water.

2.3 KITCHEN HOOD DUCT INSULATION & FIRE RATED AIR DUCTWORK

- A. Materials: Non-mineral wool, passive, low biopersistent fiber, ceramic blanket insulation totally encapsulated on all sides with aluminum foil scrim on kitchen hood exhaust duct.
- B. Installation shall be 2 layer, 1-1/2" thick to provide 2-hour protection on grease duct. Apply directly to the duct with zero clearance to combustibles through the length of the assembly.
- C. Secure with metal bands per manufacturer's recommendations on type and spacing. For ducts spacing 24" or greater, secure with insulation pins on the bottom of horizontal runs and on vertical runs to prevent sagging.
- D. Manufacturers: Thermal Ceramics - Firemaster Duct Wrap XL or Plus, Pyroscat Ductwrap XL, or Unifrax Fyre Wrap ®.

2.4 ACOUSTIC DUCT LINER

- A. Duct liner shall be designed for use as an acoustical insulation to absorb air conditioning noise in sheet metal ducts and plenums operating at velocities up to 6000 fpm and temperatures up to 250 deg. F.
- B. Duct liner shall be a bonded mat of glass fibers coated with an EPA registered biocide and a black pigmented fire-resistant coating on the air stream side.
- C. Duct liner shall comply with the requirements of NFPA 90A and 90B. Surface burning characteristics shall comply with UL Standard 723 for 25/50 flame and smoke development.
- D. Duct liner shall comply with the property requirements of ASTM Specification C1071 Type 1, or ASTM C1534. Material shall resist fungal and bacterial growth when subjected to ASTM G21 and G22 test methods.
- E. Material thickness, name of manufacturer and type shall be printed on the air stream side of the liner for ease of identification.
- F. Duct liner shall be 2" thick, unless otherwise noted on the drawings and achieve minimum NRC0.70 acoustic performance.
- G. Manufacturers: Owens Corning QuietR® AcousticR™ Duct Liner, Certaineed, Evonik Industries Solcoustic, Johns Manville Linacoustic® RC.

2.5 REUSABLE VALVE COVERS

- A. All valves, strainers, combination valves, etc. in chilled water and heating hot water systems shall be insulated with a factory fabricated removable and reusable cover. (This product shall not be used for pipe and fittings.)
- B. Insulation shall be either fiberglass blanket or flexible elastomeric thermal insulation as listed in Paragraph 3.2 of this specification, or prefabricated fitting from the supplier. Flame and smoke spread shall be 25/50 per ASTM 84.
- C. Outer jacket shall be made of material equal to Tychem QC, overlap and completely cover the insulation, with seams joined by tabs made from Velcro or fabric straps per manufacturer's standards.
- D. Outer jacket shall overlap adjoining sections of pipe insulation, and shall be non-combustible, impermeable to water, and prevent mold, mildew and condensation.
- E. Installation shall not require the use of any special hand tools.
- F. Manufacturers: Corick Valve Covers, NoSweat Valve Wraps.

2.6 INSULATED PIPE SADDLES

- A. Insulation and facing shall each meet 25/50 flame and smoke ratings per ASTM E-84 on a component basis.
- B. A section of rigid insulation shall be used at all cold pipe hangers or support locations and shall consist of:
 - 1. A rigid 3.75 PCF phenolic foam pipe insulation designed to support pipe sizes up to and including 6" iron pipe size.
 - 2. A rigid 5 PCF phenolic foam pipe insulation designed to support pipe sizes from 8" to 30" iron pipe size.
 - 3. For all hot pipe hanger or support locations, the insert material shall be either rigid calcium silicate per ASTM C303 or perlite silicate per ASTM C303 with all service jacket and laminated to a steel support saddle.
- C. The insulation jacket shall contain a vapor retarding material to provide low moisture vapor permeability and resistance to mold, mildew and fungus growth.
- D. The insulation shall be free of any CFC or HCFC materials.
- E. The insulation shall have a minimum K-factor of 0.13 at 75 deg. F mean temperature, and self-sealing lap joint with high performance acrylic pressure sensitive adhesive tape.
- F. Integral insulation saddle shall be made of G-90 carbon steel, with full 180 deg. Coverage, flared edges to protect the vapor barrier jacket and insulation, and short rib surface to center the saddle inside the hanger and prevent movement.
- G. Preformed insulation shall extend beyond the saddle by a minimum of 1-1/2" to accommodate a tape joint seal at the butt edges of adjoining insulation sections.
- H. Minimum product dimensions shall be as follows:

Nominal pipe size (inches)	Insulation density (PCF)	Insulation length (inches)	Saddle length (inches)	Saddle gauge
1/2 - 3-1/2	3.75	9	6	20
4 - 6	3.75	12	9	18
8 - 18	5.0	18	12	16
- I. Manufacturer: Tru-Balance insulated saddles as made by Buckaroos, Inc.

PART 3 – EXECUTION

3.1 INSTALLATION – GENERAL

- A. Do not install until systems have been tested and meet requirements.
- B. Do not install until building is enclosed.
- C. Heavy work which may damage insulation shall have been completed in the vicinity of the insulation work.
- D. Provide non-compressible insulation saddles at all piping hanger locations, and at all piping hanger locations where piping is insulated with flexible closed cell insulation.
Option: Provide insulation coupling system as made by Klo-Shure Co.
- E. All installations shall be made by skilled craftsmen regularly engaged in this type of work.
- F. Insulation shall be continuous thru-wall, ceiling and floors.
- G. Metal shields, 16 gauge galvanized, shall be installed between hangers and pipe insulation.
- H. Pipe, ductwork and equipment shall be clean and dry prior to insulating.
- I. Install all insulation per manufacturer's instructions.
- J. To avoid undue compression of insulation, provide solid core inserts at all supports as recommended by the insulation manufacturer. Provide insulation shields between the insulation jacket and the hanger.
- K. Ductwork treated with internal acoustic duct liner does not require external insulation.
- L. Apply vapor proof mastic as recommended by the insulation manufacturer on all longitudinal and butt joints of sectional pipe insulation. Apply similar mastic to the end of every third length of sectional pipe insulation on all chilled water and dual temperature pipe insulation to prevent the migration of condensation that might occur.
- M. For pre-manufactured expansion loops, provide a second layer of insulation with air gap to maintain loop flexibility. Install in accordance with the loop manufacturer's written instructions.
- N. Provide insulation on all piping, equipment, and fixtures that are part of a factory assembly package not otherwise insulated by the manufacture of such packaged equipment. Insulation type and thickness shall comply with all of the requirements of this section.

3.2 PIPE INSULATION – TYPES & THICKNESSES

- A. Provide fiberglass insulation of thickness specified on:
 - 1. Cold Water Make-Up:
 - 1/2" for piping 1-1/4" and below.
 - 1" for piping 1-1/2" and over
 - 2. Heating Hot Water: (Up to 140°F)
 - 1" for piping 1-1/4" and below
 - 1-1/2" for pipes 1-1/2" and over.
 - 3. Heating Hot Water: (141°F to 200°F)
 - 1-1/2" for piping 1-1/4" and below
 - 2" for pipes 1-1/2" and over.
 - 4. Chilled Water:
 - 1" for piping 1-1/4" and below. Option: Flexible closed cell insulation
 - 1" for piping 1-1/2" and over

5. Dual Temperature Water:
 - 1-1/2" for piping 1-1/4" and below. Option: Flexible closed cell insulation
 - 2" for piping 1-1/2" and larger
 6. Refrigerant Piping: Interior locations, exposed and concealed for suction lines and hot gas bypass lines, if applicable. (NOTE: Insulate liquid line if metering device is mounted at the condensing unit.) Option: Flexible closed cell insulation
 - a. Suction Line:
 - 1" for piping 1-1/4" and below
 - b. Liquid Line:
 - 1" for piping 1-1/4" and below
 - c. Hot Gas Bypass: (Liquid Line)
 - 1" for piping 1-1/4" and below
 - 1-1/2" for piping 1-1/2" and larger
 7. Freeze protection of outdoor piping (over heat tracing tape): 3" thick insulation, with metal jacket.
- B. Provide flexible closed cell insulation of thickness specified on:
1. Refrigerant Piping: Exterior Locations for suction lines and hot gas bypass lines, if applicable. (NOTE: Insulate liquid line if metering device is mounted at the condensing unit.)
 - a. Suction Line:
 - 1" for piping 1-1/4" and below
 - b. Liquid Line:
 - 1" for piping 1-1/4" and below
 - c. Hot Gas Bypass: (Liquid Line)
 - 1" for piping 1-1/4" and below
 - 1-1/2" for piping 1-1/2" and larger
 2. Cold surfaces of refrigeration equipment, air separators for chilled and heating hot water, and chilled water pumps. 3/4" thickness
 3. Hot and chilled water expansion tanks. 3/4" thickness
 4. 1" thickness for all water piping within terminal unit cabinets.
 5. 1/2" thickness for condensate drain lines.
- 3.3 PIPE COVERING (FOAMED PLASTIC TYPE)
- A. All joints and seams shall be sealed with a compatible adhesive. Approved adhesives are as follows:

Armstrong World Industries	No. 520
Benjamin Foster Company	No. 85-75 up to 200 degrees F.

 Contractor may use Armstrong Self-Seal Armaflex 2000 insulation in lieu of the above wherever 1/2" is specified.
 - B. Fitting covers shall be fabricated from the foamed plastic pipe insulation or from sheet insulation of the identical material. The fabrication shall be in accordance with manufacturer's instructions, and all seams mitered joints shall be joined using the adhesives described hereinbefore.
 - C. Pipe insulation in concealed spaces shall require no finish coatings.

- D. Pipe insulation in all other areas shall receive two coats of finish of color selected by Architect. Approved finishes are as follows:

Armstrong World Industries WB Armaflex Finish

3.4 EXTERIOR PIPE COVERING

- A. Wrapping: Wrap insulation with embossed 0.016" aluminum jacket, orient seam down.
- B. Fastenings: Cover shall be held in place with soft aluminum bands on 12" centers.
- C. Valves and Fittings:
 - 1. Weatherproof all valves and fittings.
 - 2. Finish: Apply two coats of vapor resistant mastic reinforced with glass fabric over wrapping.

3.5 INTERIOR PIPE COVERING

- A. Provide premolded PVC cover on all interior insulated piping exposed in finished spaces. Orient seams up in overhead piping and toward the wall in vertical runs.
- B. Provide factory molded fitting covering for fittings and accessories, sealed and held in place by manufacturer's recommended sealing system.
- C. Provide mitered sections of covering for valves.

3.6 ACOUSTIC DUCT LINER

- A. All portions of duct designated on the drawings to receive duct liner shall be completely covered with duct liner, adhered to the sheet metal with a 100% coverage of adhesive complying with ASTM C916.
- B. Transverse joints shall be neatly butted and there shall be no interruptions or gaps. All transverse joints and all exposed leading edges shall be coated. The black coated surface of the duct liner shall face the airstream.
- C. Duct liner shall be secured with mechanical fasteners which shall compress the duct liner sufficiently to hold it firmly in place.
- D. Duct liner shall be cut to assure overlapped and compressed longitudinal joints.
- E. After installation is complete, blow out the duct system prior to operation to remove any cutting scraps and foreign material remaining in the duct.

3.7 INSULATED PIPE SADDLES

- A. Insulated pipe saddles shall be installed at all hangers, rollers or supports in accordance with manufacturer's written instructions.
- B. All piping shall be clean and free of oil, rust and moisture prior to and during support installation.
- C. All insulated saddles and accessories shall be stored in a dry area protected from weather before and during installation
- D. Seal adjoining butt edges of pipe insulation with approved mastic and tape to insure continuity of the insulation jacket and vapor barrier, especially on cold piping system installations.

END OF SECTION

SECTION 23 03 00

VIBRATION AND SOUND ISOLATION – HVAC

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the contract, including the conditions of the contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the work specified in this section.
- B. Refer to Section 230200 for HVAC General Provisions
- C. Refer to Section 230210 for HVAC Basic Materials & Methods.

1.2 DESCRIPTION OF WORK

- A. This Section includes providing the following vibration and sound isolation material on items furnished and installed under HVAC work:
 - 1. Pump-mounted inertia pads
 - 2. Piping, Inline Pumps
 - 3. Fans and AHU's
 - 4. Suspended Exhaust Fans
 - 5. Rooftop AHU's

1.3 REFERENCE STANDARDS

- A. Refer to Section 230200 for a general description of requirements applying to this section.

1.4 QUALITY ASSURANCE

- A. Refer to Section 230210 for a general description of requirements applying to this section.

1.5 SUBMITTALS

- A. Submit shop drawings, installation instructions, and manufacturer's literature of all materials specified in accordance with Section 230200.
- B. Submit the following:
 - 1. Shop drawings
 - 2. Product data

1.6 WARRANTY/GUARANTEE

- A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, General Requirements.

PART 2 – PRODUCTS

2.1 GENERAL

- A. All vibration control apparatus shall be furnished by a single recognized manufacturer. The manufacturer shall submit to the Architect/Engineer evidence affirming that he has been a supplier of vibration control devices of the type required for the past five years.
- B. The vibration control apparatus manufacturer shall supervise, inspect, measure, and approve the installation and shall submit a report to the Architect/Engineer substantiating that all the equipment has been adequately isolated.
- C. Any requests for changes in the specifications must be submitted in writing in time for review and approval through a written addendum to the specifications prior to bid closing.

- D. Unless otherwise indicated or specified, all equipment mounted on vibration isolator bases shall have a minimum operating clearance of 1 inch between the base and the floor or housekeeping and beneath. Clearance space shall be checked to ensure that no scrap, rubbish, hardware, etc., has been left to possibly short circuit isolated base.
- E. In connecting isolated HVAC equipment to rest of system, care must be exercised to insure proper installation.
 - 1. Equipment connected to water piping shall be erected on isolators or isolated foundations to correct operating height prior to making piping connections to avoid misalignment problems. To facilitate this, equipment shall be blocked-up with temporary shims to final operating height. When full load is assembled and water is in system, isolators shall then be adjusted to take up load just enough to allow removal of shims.
 - 2. Air handling equipment such as centrifugal fans shall be erected on isolators and leveled with fan operating before flexible duct connection is made. Insure that duct position is in proper alignment and providing proper clearance in proportion to flexible duct connector length. When fan is shut off, misalignment with ductwork is allowable providing it does not strain or damage flexible duct connector. In cases of high static pressure, fans requiring position stabilizers are to be adjusted when fan is operating to achieve the results as described above with isolator adjustment.
- F. Vibration isolator sizes and location shall be determined by the vibration control products manufacturer or as specified herein.
- G. Model numbers of Amber/Booth Co., are given for identification. Products of specified manufacturers will be acceptable, provided they comply with all of the requirements of this specification.

2.2 ISOLATOR TYPES

- A. Pump Mounted Inertia Pads:
 - 1. Frame to be structural steel with built-in height saving bracket for recessing into a CPF concrete inertia block for side access.
 - 2. Spring to be adjustable, free-standing, open-spring mounting with combination leveling bolt and equipment fastening bolt. The spring shall be rigidly attached to the spring mounting baseplate and compression plate. The isolator shall be designed for a nominal static deflection of 2.0 in.. A neoprene pad having a minimum thickness of 1/4" shall be bonded to the baseplate. Amber/Booth Type CPF with RSW-1, Mason SLF.
- B. Piping in Mechanical Room, In-Line Pumps (Nominal Static Deflection 1.0 in.):
 - 1. Type PBSR: for first two hangers in horizontal piping adjacent to isolated equipment and for all hangers on 8" and larger pipe, except the first two hanger points adjacent to riser shall be Type BS.
 - 2. Type BSR for remaining hangers in horizontal piping.
 - 3. Type SW for pipe risers. Isolator base plates shall be provided with holes for bolting and isolation grommets.
 - 4. Type SW for floor supports except Type CT for first floor support adjacent to equipment isolated on CT isolators.
 - 5. All piping and mechanical appurtenances, including heat exchangers and air separators, connected to vibration-isolated equipment should be isolated from the building structure by means of vibration isolators, resilient lateral supports, and resilient penetration sleeve/seals. This measure applies to the first 50 feet total pipe length, or to the entire pipe within the

mechanical room, whichever is longer. Pipes with a 4-inch diameter, or larger, should be isolated throughout the building.

6. Isolators for the first three support points adjacent to connected equipment, and piping and mechanical appurtenances noted above, should achieve the same specified static deflection as the isolators supporting the connected equipment. Isolators similar to Mason model SLF or Mason 30N should be used when their required static deflection is greater than 1/2-inch. Isolator Mason models ND or HD should be used when the required static deflection is less than or equal to 1/2 -inch. All other pipe support isolators within the specified limits should be either Mason model ND or HD achieving at least 1/4 -inch static deflection.

Electrical conduit connected to the vibration isolation equipment should be connected either by using a special flex electrical coupling or a section of flex conduit installed in a slack condition.

C. Fans and Air Handling Units:

1. For slab on-grade installations, provide:
 - a. Type SP – NR = Double Deflection Neoprene: Shall include neoprene covered steel support plated (top and bottom), friction pads, and necessary bolt holes. Design isolators to support loads up to 50 pounds per square inch.
2. For floors above-grade, up to 40 ft. span, provide:
 - a. Type SW = Spring Isolators: Shall be free-standing, laterally stable and include acoustical friction pads and leveling bolts. Isolators shall have a minimum ratio of spring diameter-to-operating spring height of 1.0 and an additional travel to solid equal to 50 percent of rated deflection.
 - b. Type PBSRA - Combination Neoprene and Spring: Vibration hanger shall contain a spring and double deflection neoprene element in series. Spring shall have a diameter not less than 0.8 of compressed operating spring height. Spring shall have a minimum additional travel of 50 percent between design height and solid height. Spring shall permit a 15 degree angular misalignment without rubbing on hanger box.
 - c. Thrust Restraints: Restraints shall provide a spring element contained in a steel frame with neoprene pads at each end attachment. Restraints shall have factory preset thrust and be field adjustable to allow 1/4" maximum movement when the fan starts and stops. Restraint assemblies shall include rods, angle brackets and other hardware for field installation.

D. Suspended Exhaust Fans (Nominal Static Deflection 1.0 in)

1. For floors above-grade, up to 40 ft. span, provide:
 - a. Type SW = Spring Isolators: Shall be free-standing, laterally stable and include acoustical friction pads and leveling bolts. Isolators shall have a minimum ratio of spring diameter-to-operating spring height of 1.0 and an additional travel to solid equal to 50 percent of rated deflection.
 - b. Type PBSRA - Combination Neoprene and Spring: Vibration hanger shall contain a spring and double deflection neoprene element in series. Spring shall have a diameter not less than 0.8 of compressed operating spring height. Spring shall have a minimum additional travel of 50 percent between design height and solid height. Spring shall permit a 15 degree angular misalignment without rubbing on hanger box.
 - c. Thrust Restraints: Restraints shall provide a spring element contained in a steel frame with neoprene pads at each end attachment. Restraints shall have factory preset thrust and be field adjustable to allow 1/4" maximum movement when the fan starts and stops.

Restraint assemblies shall include rods, angle brackets and other hardware for field installation.

E. Rooftop AHU's:

1. Type RTIR: Provide an extruded aluminum rail base for rooftop air conditioning units consisting of a pair of weatherproofed aluminum rails for fastening to equipment and to roof curb incorporating wind restraints and a continuous air and water seal which is protected from accidental puncture and direct sunlight by an aluminum weather shield. Rails shall incorporate non-adjustable Type SW spring isolators properly spaced around perimeter and sized for 2" deflection. To prevent leaks, rails shall be factory assembled (to the limits of freight carriers) and shipped as a one- piece unit.

F. Manufacturers: Amber/Booth, Kinetics Noise Control, Mason Industries, Vibration Mounting & Controls, Vibration Eliminator, Inc., Vibro-Acoustics.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's specifications and instructions.

1. No metal-to-metal contact will be permitted between fixed and floating parts.
2. Connections to Equipment: Allow for deflections equal to or greater than equipment deflections. Electrical, drain, piping connections, and other items made to rotating or reciprocating equipment (pumps, compressors, etc.) which rests on vibration isolators, shall be isolated from building structure for first three hangers or supports.
3. Common Foundation: Mount each electric motor on same foundation as driven machine. Hold driving motor and driven machine in positive rigid alignment with provision for adjusting motor alignment and belt tension. Bases shall be level throughout length and width. Provide shims to facilitate pipe connections, leveling and bolting.
4. Provide heat shields where elastomers are subject to high temperatures.
5. Extend bases for pipe elbow supports at discharge and suction connections at pumps. Pipe elbow supports shall not short circuit pump vibration to structure.

B. Inspection and Adjustments: Check for vibration and noise transmission through connections, piping, ductwork, foundations, and walls. Adjust, repair or replace isolators as required to reduce vibration and noise transmissions to specified levels.

END OF SECTION

SECTION 23 04 00 HEATING GENERATION EQUIPMENT

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the work specified in this section.
- B. Refer to Section 230200 for HVAC General Provisions.
- C. Refer to Section 230210 for HVAC Basic Materials and Methods.
- D. Refer to Section 230230 for Insulation and Covering – HVAC

1.2 DESCRIPTION OF WORK

- A. This Section includes labor, material, and equipment necessary to provide a complete boiler system as specified herein and shown on the drawings:
 - 1. Boilers - General
 - 2. Boilers – (Condensing Type)
- B. Refer to other Division 23 sections for related work.

1.3 REFERENCE STANDARDS

- A. Refer to Section 230200 for a general description of requirements applying to this Section.
- B. See specifications in this Section for specific compliance with NFPA, UL, ASME, etc.
- C. Underwriters Laboratories:
 - 1. UL 795: Commercial-Industrial Gas Heating Equipment.
- D. American Society of Mechanical Engineers:
 - 1. ASME Section IV: Boiler and Pressure Vessel Code - Heating Boilers
 - 2. ASME CSD-1: Controls and Safety Devices for Automatically Fired Boilers
- E. American Society of Heating, Refrigeration and Air Conditioning Engineers:
 - 1. ASHRAE: Standard 90.1 Energy Standard for Buildings
- F. American National Standards Institute
 - 1. ANSI Z21.13: Gas Fired Low Pressure Steam and Hot Water Boilers
- G. Hydronics Institute, Division of Air Conditioning, Heating and Refrigeration Institute:
 - 1. BTS-2000: Testing Standard to Determine Efficiency of Commercial Space Heating Boilers
- H. National Fire Protection Association:
 - 1. NFPA 54: National Fuel Gas Code (ANSI Z223.1).

1.4 QUALITY ASSURANCE

- A. Refer to Section 230210 for a general description of requirements applying to this section.
- B. Quality Assurance:
 - 1. Manufacturers: Firms regularly engaged in manufacture of boilers, of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.
 - 2. Regulatory Requirements:
 - a. NFPA Compliance: Install boilers in accordance with National Fire Protection Association (NFPA) Code 54 "National Fuel Gas Code".

- b. NFPA 211 Compliance: Heating equipment burning gas, solid or liquid fuels, Section 60.
 - c. ASME, CSD-1
- 1.5 SUBMITTALS
 - A. Submit shop drawings and product data in accordance with Section 230200.
 - B. Submit the following:
 - 1. Shop Drawings
 - 2. Product Data
 - 3. Evidence of specified code or other compliance.
- 1.6 SUBSTITUTIONS
 - A. The listed equivalent or substituted manufacturers along with the bidding related contractor shall be completely responsible to comply with all requirements on all contract documents. This shall include, but not be limited to, space requirements, code clearances, the type, horsepower, capacities, number and size of services required from other trades, including all required ancillary items furnished and installed by other trades. If the manufacturer or related bidding contractor does not comply with these requirements, this Contractor shall be responsible for any and all additional costs associated with the changes required by other trades.
- 1.7 WARRANTY/GUARANTEE
 - A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, GENERAL REQUIREMENTS. In addition, the following special guarantee applies:
 - 1. Start-up and two years of factory service on boilers.
 - 2. The stainless-steel heat exchanger shall carry a 10-year limited warranty.
 - 3. Pressure vessel and flue collector are covered against failure due to fireside flue gas corrosion: upper and lower pressure vessel headers shall carry a 10-year limited warranty and flexible boiler tubes and flue collector sides, top and bottom, shall carry a 5-year limited warranty.
 - 4. The burner shall carry a 2-year limited warranty.
 - 5. All other parts shall have a 2-year limited warranty.

PART 2 – PRODUCTS

2.1 BOILERS - GENERAL

- A. Provide factory packaged type boiler, burner units for hot water heating units arranged for automatic firing with natural gas. Each unit shall include an internal, header type boiler, insulated metal jacket, pre-engineered combustion system consisting of a special vertical gas burner with forced draft wind box, refractory type combustion chamber and precut block insulation, factory wired NEMA 1 control panel for combustion programming and flame failure protection, integral draft inducer and all operating and limit controls in accordance with CSD-1. Each unit shall be provided with all castings, fittings, accessories and appurtenances necessary for assembly, connection and operation, including safety/relief valves, water column type pump control and lower water cutoff with precut piping and necessary fittings, prefabricated return yoke together with gauges and instruments as hereinafter described. Boiler/Burner package shall be a standard product of the manufacturer.

2.2 BOILER – CONDENSING TYPE

- A. Boiler
 - 1. The boiler shall be assembled, firetested and shipped as a factory-packaged unit, complete with jacket, gas manifold, burner and controls mounted & wired, with boiler connections specified in this Section.

2. The boiler shall be constructed in conformance to ASME Section IV, ASME CSD-1 and UL 795. The boiler shall bear the ASME “H” stamp with a maximum allowable working pressure (MAWP) of 160 PSI.
 3. The boiler shall be an ultra-high efficiency condensing boiler with a pressure vessel, constructed of 316L stainless steel and of water tube design, which shall not require a refractory combustion chamber.
 4. The boiler shall be equipped with an integral pre-mix, stainless steel forced draft burner incorporating full modulation with minimum 5:1 turndown. Burner shall be equipped with a sliding guide rail with hinged door to gain full access and inspection of the burner and combustion chamber.
 5. The boiler gas valve will be designed with zero pressure regulation and equipped with a variable speed blower system.
 6. A factory supplied oversized ASME relief valve shall be provided with the boiler(s).
 7. The flue passages and combustion chamber shall be accessible for cleaning.
 8. The boiler shall be provided with a heavy duty 16-gauge steel jacket with a rust resistant powder coat finish. Jackets made of plastic or resin material shall not be acceptable. The boiler jacket shall contain an internal electrical cabinet for power and limit circuit wiring. Electrical connections shall be accessible on printed circuited boards (120VAC high and 24VAC/5VDC low voltage) with fused connections for protection and clear labeling for simple and accurate wiring.
 - a. The electrical components shall be separated from incoming combustion air gas.
 9. A polypropylene condensate trap with a float-actuated shut-off switch shall be supplied with the boiler.
 10. Electrical input to the boiler shall be 120v/1ph/60hz or 460v/3ph/60hz.
- B. Boiler Control System
1. Boiler Control System shall provide safety interlocks and water temperature control. The control system shall be fully integrated into the boiler control cabinet and incorporate single and multiple boiler control logic, inputs, outputs and communication interfaces. The control system shall simply control boiler modulation and on/off outputs based on the boiler water supply temperature and an operator-adjusted setpoint. The control system shall allow the boiler to respond to energy management system (EMS) firing rate demand, remote setpoint or remote start/stop commands.
- C. Boiler Trim
1. Combination pressure-temperature gauge.
 2. Supply and return temperature sensors
 3. Flue gas temperature sensor
 4. ASME Section IV safety relief valve sized to exceed the gross output of the boiler which shall be factory set to relieve pressure at 50 psig water working pressure.
 5. Water flow switch.
 6. High Temperature Limit, automatic and manual reset
 7. High and low gas pressure switches with manual reset
 8. Low water cutoff (LWCO) device with manual reset
- D. Guarantee: The boiler shall be provided with start-up by factory trained personnel.
- E. Manufacturers: Aerco, Fulton, Thermal Solutions, Raypak.

1. Any listed equivalent manufacturer and the Mechanical Contractor shall be completely responsible to comply with all requirements on the contract documents. This shall include, but not be limited to, space requirements, code clearances, the type, horsepower, capacities, number and size of services required from other trades.

PART 3 – EXECUTION

3.1 BOILER-BURNERS

A. Install per Manufacturer's Written Instructions:

1. Properly level.
2. Set bottom of framework on concrete pad. The Contractor shall construct level concrete pad and foundations according to the manufacturer's erecting instructions. Mount boilers on 6" high concrete pads. Provide pads, with beveled edges.
3. Pipe all relief valves, blowoffs and drains to the floor drains. Pipe size shall not be less than tapping on boiler, low water cutoff, etc.
4. Adequately protect boiler-burner unit during construction.
5. Pipe all gas vents to exterior in accordance with CSD-1 and utility company requirements. Terminate with screened vent head.
6. Insulate all factory installed piping for hot water as applicable.

B. Start-up, Contractor shall:

1. Employ the services of approved water treatment consultant who shall:
 - a. Test water before filling boiler and prescribe proper water treatment to prevent corrosion or deterioration due to oxygen, acid or scaling.
 - b. Immediately after internal inspection and refilling of boiler, check water conditions at that time and prescribe proper water treatment again.
2. Be responsible for:
 - a. Supplying and using prescribed ingredients. (initial water treatment)
 - b. Maintain proper water conditions until acceptance of boiler. After acceptance of boiler, water treatment will be provided by the Owner.
 - c. Cleaning systems as specified.
 - d. Not filling boiler until firing equipment is operable.
3. As soon as boiler is filled, ready for testing, or final acceptance.

C. Testing and Cleaning:

1. Bring water up to 210°F and circulate for two hours to drive off air.
2. Demonstrate all safety devices in presence of Owner's Representative and Engineers before final acceptance.
3. Set maximum firing rate of boiler.
4. Skim off impurities until boiler water is clear.

D. Services of Factory mechanic:

1. Arrange to have services of a factory representative trained field mechanic on site to start up the boiler(s).
2. Mechanic shall check out entire installation, including all pumps and feed apparatus and controls, shall start the units into operation and shall make all necessary tests and adjustments to have said equipment operate to his and to the Engineer's satisfaction.

3. Manufacturer shall issue a letter stating that the installation has been checked and adjusted and is ready to turn over to the Owner following the completion of this work.
 4. Manufacturer is to forward three (3) copies of the starting reports to the Owner.
 5. Factory mechanic shall be at the job for the initial start-up for not less than two (2) consecutive calendar days.
 6. Factory mechanic shall conduct demonstration and combustion tests in the presence of the Owner for each boiler for gas firing and oil fire and shall submit written report to the Owner.
 7. The same factory mechanic shall make two more trips to the job within the succeeding eight months from the date of the above-mentioned letter for the purpose of further adjusting and checking and shall be immediately available in the event of operating failure of the units within a period of one year from the date of the letter.
- E. Tools and spare Parts for Each Boiler: Furnish and obtain receipt for complete set of gaskets, flue brush and scraper with light weight handles and all special tools that may be required.

END OF SECTION

SECTION 23 04 10**HEATING GENERATION AUXILIARY EQUIPMENT****PART 1 – GENERAL****1.1 RELATED DOCUMENTS**

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the work specified in this section.
- B. Refer to Section 230200 for HVAC General Provisions.
- C. Refer to Section 230210 for HVAC Basic Materials and Methods.
- D. Refer to Section 230400 for Heating Generation Equipment.

1.2 DESCRIPTION OF WORK

- A. This Section includes labor, material, and equipment necessary for a complete boiler system as specified and shown on the drawings:
 - 1. Gas Vent Pipe & Pipe Fittings
 - 2. Miscellaneous Breeching Materials
- B. Provision for boiler vent and combustion air piping.
- C. Refer to other Division 23 sections for related work.

1.3 REFERENCE STANDARDS

- A. Refer to Section 230200 for a general description of requirements applying to this section.

1.4 QUALITY ASSURANCE

- A. Refer to Section 230210 for a general description of requirements applying to this section.
- B. Quality Assurance:
 - 1. Manufacturers: Firms regularly engaged in manufacture of equipment types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.
 - 2. Regulatory Requirements:
 - a. NFPA Compliance: Install gas-fired boilers in accordance with National Fire Protection Association (NFPA) Code 54 "National Fuel Gas Code".
 - b. NFPA 211 Compliance: Heating equipment burning gas, solid or liquid fuels, Section 60.

1.5 SUBMITTALS

- A. Submit shop drawings and product data in accordance with Section 230200.
- B. Submit the following:
 - 1. Shop Drawings
 - 2. Product Data
 - 3. Evidence of specified code or other compliance.

1.6 SUBSTITUTIONS

- A. The listed equivalent or substituted manufacturers along with the bidding related contractor shall be completely responsible to comply with all requirements on all contract documents. This shall include, but not be limited to, space requirements, code clearances, the type, horsepower, capacities, number and size of services required from other trades, including all required ancillary items furnished and installed by other trades. If the manufacturer or related bidding contractor does not

comply with these requirements, this Contractor shall be responsible for any and all additional costs associated with the changes required by other trades.

1.7 WARRANTY/GUARANTEE

- A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, GENERAL REQUIREMENTS

PART 2 – PRODUCTS

2.1 GAS VENT PIPE & FITTINGS

- A. The gas vent system shall be so engineered and constructed as to develop a positive flow adequate to exhaust all flue gases to outside atmosphere, without condensation within the vent.
- B. All parts of vent system shall be of Underwriters' Laboratories, Inc., listed Metal-Fab Type CORR/Guard Model CG, double wall gas vent piping, and such piping shall be continuous from the appliance outlets into Metal-Fab vent terminal. Venting System shall be rated at 6" W.C. and tested to 15" W.C. per UL Standard 1738.
- C. The Metal-Fab gas vent piping shall be installed in full compliance with the terms of its listing, with the manufacturer's installation instructions, and with nationally recognized building codes representing good practice for such installations.
- D. For vent sizes 6" to 12" inside diameter, inner wall thickness shall be 0.015", Type AL29-4C stainless steel.
Outer casing shall be 0.018", aluminized steel.
- E. Inner and outer walls shall be connected by means of spacer clips that maintain concentricity of the annular space and allow differential thermal expansion of the inner and outer walls.
- F. All supports, wall penetration, terminal with miter cut and birdscreen, boiler connector and condensate drain fitting shall be included.
- G. All joints shall be sealed using manufacturer's approved sealant. Joints exposed to the weather shall be sealed to prevent rainwater from entering the annular space between inner and outer walls.
- H. Provide adequate accessibility, head room and dimensions so that all vent connections can be correctly sized, spaced and supported.
- I. Manufacturers: Metal-Fab, Metalbestos, Heat Fab, Inc., American Metal Products, Van-Packer Co.

2.2 MISCELLANEOUS BREECHING MATERIALS

- A. Provide miscellaneous materials and products of types and sizes to comply with boiler requirements including proper connection of equipment.
- B. Provide PVC combustion air intake pipe and accessories:
1. Pipe: ASTM D-1785 Schedule 40, Type 1, Grade 1.
 2. Fittings: ASTM D-2466, Schedule 40.
 3. Solvent Cement: ASTM D-2564, Schedule 40 and DWV.
 4. Uniformity: To ensure installation uniformity, all piping components shall be of one manufacturer.
 5. Flux shall be non-toxic type and non-corrosive.

PART 3 – EXECUTION

3.1 BOILER GAS VENT PIPE

- A. Gas vent pipe shall be installed in accordance with the latest International Mechanical Code.

3.2 GAS VENT PIPE (PRE-ENGINEERED)

- A. The manufacturer shall warrant the complete system against functional failure due to defects in material and workmanship for 10 years from date of delivery. The system manufacturer shall be responsible for checking the sizing, design, and installation of the system. If any component fails to perform its intended function of exhausting combustion by-products from the boiler equipment, for any reason, within 10 years of shipment, the system supplier shall, at no expense to the Owner, provide a replacement part or parts FOB jobsite.

END OF SECTION

SECTION 23 04 50 REFRIGERATION EQUIPMENT – HVAC

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the contract, including the conditions of the contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the work specified in this section.
- B. Refer to Section 230200 for HVAC General Provisions
- C. Refer to Section 230210 for HVAC Basic Materials & Methods.

1.2 DESCRIPTION OF WORK

- A. This Section includes labor, material, equipment and supervision to for the following:
 - 1. Air-Cooled Water Chiller
 - 2. Split System Heat Pump Unit
 - 3. Ductless Split system Cooling Unit
 - 4. Condensing Unit (10-20 Tons)
- B. Provide complete refrigeration system including chillers, cooling towers, aboveground piping and all required accessories.

1.3 REFERENCE STANDARDS

- A. Refer to Section 230200 for a general description of requirements applying to this section.
- B. Comply with applicable provisions of:
 - 1. International Mechanical Code
 - 2. ASME Codes for Pressure Vessels
 - 3. A.R.I. Capacity Ratings
 - 4. NFPA Pamphlets
 - 5. ASHRAE Standard 15
 - 6. ASHRAE Standard 90.1, Section 6, Table 6.8.1A thru J, minimum equipment efficiency.

1.4 QUALITY ASSURANCE

- A. Refer to Section 230210 for a general description of requirements applying to this Section.
- B. Whenever a variable frequency PWM drive is installed to control an AC motor, a maintenance-free, circumferential, conductive micro fiber shaft grounding ring shall be installed on the AC motor drive end to discharge shaft currents to ground. Recommended part: AEGIS SGR™ Bearing Protection Ring, as made by Electro Static Technology. Install in accordance with the manufacturer's written instructions.

1.5 SUBMITTALS

- A. Submit shop drawings and product data in accordance with Section 230200.
- B. Submit the following:
 - 1. Shop drawings and product data for all equipment in this section.
 - 2. 1/4" = 1'-0" scale layout of all equipment in Mechanical Room and adjoining chiller enclosure.

1.6 SUBSTITUTIONS

- A. The listed equivalent or substituted manufacturers along with the bidding related contractor shall be completely responsible to comply with all requirements on all contract documents. This shall include, but not be limited to, space requirements, code clearances, the type, horsepower, capacities, number and size of services required from other trades, including all required ancillary items furnished and installed by other trades. If the manufacturer or related bidding contractor does not comply with these requirements, this Contractor shall be responsible for any and all additional costs associated with the changes required by other trades.

1.7 WARRANTY/GUARANTEE

- A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, General Requirements. In addition, the following special guarantee applies:
 - 1. Manufacturer shall guarantee all refrigeration equipment including parts, for five (5) years from start-up.

PART 2 – PRODUCTS

2.1 AIR-COOLED WATER CHILLER

- A. Provide as shown on the schedules of the contract documents a factory assembled, charged, and tested air-cooled scroll compressor chillers as specified herein. Chiller shall be designed, selected, and constructed using a refrigerant with flammability rating of 1, as defined by ANSI/ASHRAE STANDARD 34 Number Designation and Safety Classification of Refrigerants. Chiller shall include not less than two refrigerant circuits above 50 tons with scroll compressors, direct-expansion type evaporator, air-cooled condenser, refrigerant, lubrication system, interconnecting wiring, safety and operating controls including capacity controller, control center, motor starting components and special features as specified herein or required for safe, automatic operation.
 - 1. Cabinet: External structural members shall be constructed of heavy gauge, galvanized steel coated with baked on power paint which, when subject to ASTM B117, 1000-hr, 5% salt spray test, yields minimum ASTM 1654 rating of 6.
 - 2. Operating Characteristics: Provide low and high ambient temperature control options as required to ensure unit is capable of operation from 30°F to 115°F ambient temperature.
 - 3. Service Isolation Valves: Discharge ball-type isolation valves factory installed per refrigerant circuit. Includes a system high-pressure relief valve in compliance with ASHRAE 15.
 - 4. Pressure Transducers and Readout Capability
 - a. Discharge Pressure Transducers: Permits unit to sense and display discharge pressure.
 - b. Suction Pressure Transducers: Permits unit to sense and display suction pressure.
 - c. High Ambient Control: Allows units to operate when the ambient temperature is above 115°F. Includes discharge pressure transducers.
- B. COMPRESSORS: Compressors shall be hermetic, scroll-type, including:
 - 1. Compliant design for axial and radial sealing.
 - 2. Refrigerant flow through the compressor with 100% suction cooled motor.
 - 3. Large suction side free volume and oil sump to provide liquid handling capability.
 - 4. Compressor crankcase heaters to provide extra liquid migration protection.
 - 5. Annular discharge check valve and reverse vent assembly to provide low-pressure drop, silent shutdown, and reverse rotation protection.
 - 6. Initial oil charge.

7. Oil level sight glass.
 8. Vibration isolator mounts for compressors.
 9. Brazed-type connections for fully hermetic refrigerant circuits.
 10. Compressor Motor overloads capable of monitoring compressor motor current. Provide extra protection against compressor reverse rotation, phase-loss and phase-imbalance.
- C. Refrigerant Circuit Components: Each refrigerant circuit shall include: a discharge service ball-type isolation valve, high side pressure relief, liquid line shutoff valve with charging port, low side pressure relief device, filter-drier, solenoid valve, sight glass with moisture indicator, electronic expansion valves, and flexible, closed-cell foam insulated suction line and suction pressure transducer.
- D. Evaporator:
1. Evaporator shall be brazed-plate, stainless-steel construction capable of refrigerant working pressure of 650 psig and liquid side pressure of 150 psig.
 2. Brazed plate heat exchangers shall be UL listed.
 3. Exterior surfaces shall be covered with 3/4" flexible, closed cell insulation, thermal conductivity of 0.26k ([BTU/HR-Ft² - °F]in.) maximum
 4. Water nozzles shall be provided with grooves for field provided ANSI/AWWA C-606 mechanical couplings.
 5. Evaporator shall include vent and drain fittings and thermostatically controlled heaters to protect to -20°F ambient in off-cycle.
 6. A 20-mesh, serviceable wye-strainer and mechanical couplings shall be provided for field installation on evaporator inlet prior to startup.
 7. Evaporator shall be provided with piping extension kit and mechanical couplings to extend liquid connection from evaporator to edge of unit. Thermal dispersion type flow switch shall be factory installed in the evaporator outlet pipe extension and wired to the unit control panel. Extension kit nozzle connections shall be ANSI/AWWA C-606 grooved pipe.
- E. Air-Cooled Condenser
1. Coils: Condenser coils shall be constructed of a single material to avoid galvanic corrosion due to dissimilar metals. Coils and headers shall be brazed as one-piece. Integral sub cooling is included. Coils shall be designed for a design working pressure of 650 PSIG. Condenser coil shall be washable with potable water under 100 psi pressure.
 2. Fan Motors: High efficiency, direct drive, 6 pole, 3 phase, insulation class "F", current protected, Totally Enclosed Air-Over (TEAO) , rigid mounted, with double sealed, permanently lubricated, ball bearings.
 3. Ultra-Quiet Fans with Variable Speed Drives. All fans shall be powered by VSDs. Fans shall provide vertical air discharge from extended orifices. Fans shall be composed of corrosion resistant aluminum hub and glass-fiber-reinforced polypropylene composite blades molded into a low-noise airfoil section. Fan impeller shall be dynamically balanced to achieve BV-5 or better per AMCA 204.05. Fan guards of heavy gauge, PVC (polyvinyl chloride) coated or galvanized steel.
- F. CONTROLS
1. General: Automatic start, stop, operating, and protection sequences across the range of scheduled conditions and transients.
 2. Power/Control Enclosure: Rain and dust tight NEMA 3R powder painted steel cabinet with hinged, latched, and gasket sealed door.

3. Microprocessor Control Center:

- a. Automatic control of compressor start/stop, anti-coincidence and anti-recycle timers, automatic pump down at system shutdown, condenser fans, evaporator pump, evaporator heater, unit alarm contacts, and chiller operation from 0°F to 125°F ambient. Automatic reset to normal chiller operation after power failure.
 - b. Software stored in non-volatile memory, with programmed setpoints retained in lithium battery backed real-time-clock (RTC) memory for minimum 5 years.
 - c. Forty-character liquid crystal display, descriptions in English, numeric data in English units. Sealed keypad with sections for Setpoints, Display/Print, Entry, Unit Options & clock, and On/Off Switch.
 - d. Programmable Setpoints (within Manufacturer limits): display language; chilled liquid temperature setpoint and range, remote reset temperature range, daily schedule/holiday for start/stop, manual override for servicing, low and high ambient cutouts, low liquid temperature cutout, low suction pressure cutout, high discharge pressure cutout, anti-recycle timer (compressor start cycle time), and anti-coincident timer (delay compressor starts).
 - e. Display Data: Return and leaving liquid temperatures, low leaving liquid temperature cutout setting, low ambient temperature cutout setting, outdoor air temperature, English or metric data, suction pressure cutout setting, each system suction pressure, liquid temperature reset via a 4-20milliamp or 0-10 VDC input, anti-recycle timer status for each compressor, anti-coincident system start timer condition, compressor run status, no cooling load condition, day, date and time, daily start/stop times, holiday status, automatic or manual system lead/lag control, lead system definition, compressor starts/operating hours (each), status of hot gas valves, evaporator heater and fan operation, run permissive status, number of compressors running, liquid solenoid valve status, load & unload timer status, water pump status.
 - f. System Safeties: Shall cause individual compressor systems to perform auto shut down; manual reset required after the third trip in 90 minutes. System Safeties include: high discharge pressure, low suction pressure, high pressure switch, and motor protector. Compressor motor protector shall protect against damage due to high input current or thermal overload of windings.
 - g. Unit Safeties: Shall be automatic reset and cause compressors to shut down if low ambient, low leaving chilled liquid temperature, under voltage, and flow switch operation.
 - h. Alarm Contacts: Low ambient, low leaving chilled liquid temperature, low voltage, low battery, and (per compressor circuit): high discharge pressure, and low suction pressure.
 - i. BAS Communications: BACnet MS/TP communication capabilities are standard.
4. Manufacturer shall provide any controls not listed above, necessary for automatic chiller operation. Mechanical Contractor shall provide field control wiring necessary to interface sensors to the chiller control system.

G. POWER CONNECTION AND DISTRIBUTION

1. Power Panels: NEMA 3R/12 rain/dust tight, powder painted steel cabinets with hinged, latched, and gasket sealed outer doors. Provide main power connection(s), control power connections, compressor and fan motor start contactors, current overloads, and factory wiring.
2. Power supply shall enter unit at a single location, be 3-phase of scheduled voltage, and connect to individual terminal blocks per compressor. Separate disconnecting means and/or external branch circuit protection (by Contractor) required per applicable local or national codes.
3. Compressor, control and fan motor power wiring shall be located in an enclosed panel or routed through liquid tight conduit.

H. ACCESSORIES AND OPTIONS

1. Microprocessor controlled; Factory installed Across-the-Line type compressor motor starters as standard.
2. Outdoor Ambient Temperature Control
3. Power Supply Connections: Single Point Circuit Breaker: Single point Terminal Block with Circuit Breaker and lockable external handle (in compliance with Article 440-14 of N.E.C.) can be supplied to isolate power voltage for servicing. Incoming power wiring must comply with the National Electric Code and/or local codes.
4. Control Power Transformer: Converts unit power voltage to 120-1-60 (500 VA capacity). Factory-mounting includes primary and secondary wiring between the transformer and the control panel.
5. Protective Chiller Panels (Factory or Field Mounted): Wire Panels (full unit): Heavy gauge, welded wire- mesh, coated to resist corrosion, to protect con- denser coils from incidental damage and restrict unauthorized access to internal components.
6. Thermal Dispersion Flow Switch (Factory installed and wired in piping extension kit): Normally open, 30bar pressure rating, stainless steel 316L construction, IP67, -4°F to 158°F ambient rating.
7. Sound Reduction (Factory installed): Compressor Acoustic Sound Blankets
8. Housed spring vibration isolators with nominal 2” static deflection.

I. Approved Manufacturers: Trane, York, Carrier, Daikin McQuay, Quantech.

1. Any listed equivalent manufacturer and the Mechanical Contractor shall be completely responsible to comply with all requirements on the contract documents. This shall include, but not be limited to, space requirements, code clearances, the type, horsepower, capacities, number and size of services.

2.2 SPLIT SYSTEM HEAT PUMP UNIT

- A.** Air conditioning system shall be a variable capacity (cool/heat) ducted or ductless split system heat pump. The system shall consist of a concealed ducted or wall mounted packaged evaporator section and matching outdoor air-cooled condensing unit. The units shall be listed by and bear the ETL label. All wiring should be in accordance with the National Electrical Code (N.E.C.). The units shall be rated in accordance with ARI Standard 240 and bear the ARI label. A full charge of R-454B refrigerant for 25 feet of refrigerant tubing shall be provided in the condensing unit. Additional refrigerant may be required based on lengths of refrigerant lines. A dry nitrogen holding charge shall be provided in the evaporator. System SEER shall meet or exceed 2021 IECC ratings.

B. High Static (Ceiling Concealed Ducted) Indoor Unit

1. The indoor unit shall be a high-performance, high static pressure capable, concealed ducted indoor fan coil with fixed horizontal duct connections and shall have a modulating expansion device (gear type).
2. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, control circuit board and fan motor.
3. The indoor unit shall have an optional leak detector. When the indoor unit detects a leak, the system shall enable mitigation control functions. The indoor unit shall include an alarm output plug for notification of leak detection.
4. The indoor unit shall feature comfort humidity control functions.
5. The indoor unit shall have an integral condensate pump as standard with 29” maximum lift and integral float switch to disable the unit in the event of condensate overflow.

6. The cabinet shall be constructed of insulated galvanized steel.
 7. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
 8. The indoor fan shall consist of three (3) speeds, High, Mid, and Low.
 9. The fan to have the ability to cycle ON/OFF.
 10. The indoor coil shall be of nonferrous construction with slit fins on copper tubing. The tubing shall have inner grooves for high efficiency heat exchange. All tube joints shall be brazed with phos-copper or silver alloy. The coils shall be pressure tested at the factory.
 11. A condensate pan and drain shall be provided under the coil.
 12. Both refrigerant lines to the indoor units shall be insulated.
 13. The unit electrical power shall be 208/230 volts, 1 phase, 60 hertz.
- C. Wall Mounted Indoor Unit:
1. The indoor unit shall be factory assembled, wired, and run tested. Unit shall contain all factory wiring, piping, control circuit board, and fan motor.
 2. The unit shall have a self-diagnostic function and auto restart function.
 3. Casing shall be certified to UL94 VO with a white finish.
 4. The indoor fan assembly shall be a cross-flow fan, direct driven by a single motor. Fan shall be statically and dynamically balanced and run on a motor with permanently lubricate bearings. The fan shall be capable of providing a minimum of 3 fan speeds (L/M/H).
 5. The fan shall have the ability to cycle ON/OFF.
 6. Motorized air sweeps and guide vanes shall provide an automatic change in airflow.
 7. The unit shall be provided with a washable permanent filter.
 8. The indoor coil shall be nonferrous construction with slit fins on copper tubing. All tube joints shall be brazed with phos-copper or silver alloy.
 9. Both refrigerant lines to the indoor unit shall be insulated.
 10. The electrical power shall be 208/230 volt, 1 phase, 60 hertz supplied from the remote condensing unit.
- D. Condensing Unit:
1. Unit shall be equipped with multiple circuit boards to perform all functions of operation.
 2. Both refrigerant lines from condensing unit to indoor evaporator shall be insulated.
 3. Unit shall have a high pressure safety switch, fuse, over-current protection, over-voltage protection, temperature limit protection logic, compressor overload sensing, and crank case heater.
 4. The chassis shall be fabricated of galvanized steel, finished with a powder coated baked enamel.
 5. Unit shall be furnished with a direct drive, variable speed propeller type fan.
 6. Unit shall contain a single electronic expansion valve to control refrigerant flow.
 7. The electrical power shall be 208/230 volts, 1 phase, 60 hertz.
- E. Controls: The control system shall be microprocessor based. The wall mounted controller shall provide a continuous display of operation status and condition. Controller shall control On/Off, operation mode (auto, cool, heat, dry, and fan), temperature setpoint, fan speed setting, and On/Off timer.
1. The auto restart feature shall automatically restart after a power failure.

F. Features:

1. Indoor unit shall have an integral condensate float switch to disable the unit if the condensate level reaches an overflow condition.
2. Condensate Pump

G. Factory installed controls shall include connections for 24-volt, hard-wired, wall-mounted thermostat, control board featuring anti-short cycle timer, 60 second post purge fan relay, on-board 30 AMP electric heat relay, and relays and connectors for condensing unit control. Provide wall-mounted solid state thermostat for field mounting and wiring to the indoor unit; the thermostat shall be capable of one-stage cooling; one-stage cooling, one-stage heating with manual changeover; one-stage cooling, two-stage heating with heat pump operation for the first stage of heat, as scheduled on the drawings.

H. Manufacturers: Carrier, Daikin McQuay, LG HVAC, Mitsubishi Electric, Samsung, Trane.

1. Any listed equivalent manufacturer and the Mechanical Contractor shall be completely responsible to comply with all requirements on the contract documents. This shall include, but not be limited to, space requirements, code clearances, the type, horsepower, capacities, number and size of services required from other trades.

2.3 DUCTLESS SPLIT SYSTEM COOLING ONLY UNIT

A. Air conditioning system shall be a variable capacity ductless split system. The system shall consist of a compact wall mounted packaged evaporator section and matching outdoor air-cooled condensing unit. The units shall be listed by and bear the ETL label. All wiring should be in accordance with the National Electrical Code (N.E.C.). The units shall be rated in accordance with ARI Standard 240 and bear the ARI label. A full charge of R-454B refrigerant for 25 feet of refrigerant tubing shall be provided in the condensing unit. Additional refrigerant may be required based on lengths of refrigerant lines. A dry nitrogen holding charge shall be provided in the evaporator. System SEER shall meet or exceed 2021 IECC ratings.

B. Wall Mounted Indoor Unit:

1. The indoor unit shall be factory assembled, wired, and run tested. Unit shall contain all factory wiring, piping, control circuit board, and fan motor.
2. The unit shall have a self-diagnostic function and auto restart function.
3. Casing shall be certified to UL94 VO with a white finish.
4. The indoor fan assembly shall be a cross-flow fan, direct driven by a single motor. Fan shall be statically and dynamically balanced and run on a motor with permanently lubricate bearings. The fan shall be capable of providing a minimum of 3 fan speeds (L/M/H).
5. The fan shall have the ability to cycle ON/OFF.
6. Motorized air sweeps and guide vanes shall provide an automatic change in airflow.
7. The unit shall be provided with a washable permanent filter.
8. The indoor coil shall be nonferrous construction with slit fins on copper tubing. All tube joints shall be brazed with phos-copper or silver alloy.
9. Both refrigerant lines to the indoor unit shall be insulated.
10. The electrical power shall be 208/230 volt, 1 phase, 60 hertz supplied from the remote condensing unit.

C. Condensing Unit:

1. Unit shall be equipped with multiple circuit boards to perform all functions of operation.
2. Both refrigerant lines from condensing unit to indoor evaporator shall be insulated.

3. Unit shall have a high-pressure safety switch, fuse, over-current protection, over-voltage protection, temperature limit protection logic, compressor overload sensing, and crank case heater.
 4. Unit shall be capable of operating in outside ambient temperature between 0 deg. F to 115 deg. F in cooling mode with optional wind baffles.
 5. The chassis shall be fabricated of galvanized steel, finished with a powder coated baked enamel.
 6. Unit shall be furnished with a direct drive, variable speed propeller type fan.
 7. Unit shall contain a single electronic expansion valve to control refrigerant flow.
 8. The electrical power shall be 208/230 volts, 1 phase, 60 hertz.
- D. Controls: The control system shall be microprocessor based. The wall mounted controller shall provide a continuous display of operation status and condition. Controller shall control On/Off, operation mode (auto, cool, dry, and fan), temperature setpoint, fan speed setting, and On/Off timer.
1. The auto restart feature shall automatically restart after a power failure.
- E. Features:
1. Condensate pump.
- F. Factory installed controls shall include connections for 24-volt, hard-wired, wall-mounted thermostat, control board featuring anti-short cycle timer, 60 second post purge fan relay, on-board 30 AMP electric heat relay, and relays and connectors for condensing unit control. Provide wall-mounted solid state thermostat for field mounting and wiring to the indoor unit; the thermostat shall be capable of one-stage cooling; one-stage cooling, one-stage heating with manual changeover; one-stage cooling, two-stage heating with heat pump operation for the first stage of heat, as scheduled on the drawings.
- G. Manufacturers: Carrier, Daikin McQuay, LG HVAC, Mitsubishi Electric, Samsung, Trane.
1. Any listed equivalent manufacturer and the Mechanical Contractor shall be completely responsible to comply with all requirements on the contract documents. This shall include, but not be limited to, space requirements, code clearances, the type, horsepower, capacities, number and size of services required from other trades.
- 2.4 CONDENSING UNIT (10-20 Tons)
- A. General:
1. Furnish air-cooled condensing unit in accordance with the performance schedule shown on the plans.
 2. Install them as shown on the plans in accordance with:
 - The manufacturer's recommendations and
 - All applicable national and local codes.
 3. UL (CSA) approved.
 4. Completely assembled for one-piece shipping and rigging.
 5. Leak, pressure and functionally tested at the factory to assure a trouble-free start-up after installation.
 6. In current production with published literature available to check performance, limitations, specifications, power requirements, dimensions, operation and appearance.
 7. Furnish with a leak detection system from the factory. When the system detects a leak, the unit controller shall initiate mitigation actions.
 8. Furnish phase monitor.

- B. Unit Enclosure:
 - 1. A steel angle frame to provide the rigid support required for shipping, rigging and years of dependable operation.
 - 2. Exterior panels of 18-gauge galvanized sheet steel which have been bonderized and finished with baked enamel to provide a long-lasting quality appearance.
 - 3. Removable panels to provide easy access to all internal components for maintenance, service and adjustment.
- C. Each compressor shall be mounted on spring isolators and shall be enclosed in a separate compartment to minimize the transmission of sound and vibration.
- D. Condenser Coils:
 - 1. Shall be draw-thru, with manufacturer's standard wire guards.
 - 2. Shall be constructed of copper tubes arranged in staggered rows and mechanically expanded into aluminum fins, and
 - 3. Shall have a separate circuit which will provide at least 19 degrees F of liquid sub-cooling at design conditions.
- E. Condenser Fan Motors:
 - 1. Shall be directly connected to the condenser fans,
 - 2. Shall have permanently lubricated ball bearings, and
 - 3. Shall have inherent overload protection.
 - 4. Motors shall be of the permanent split-capacitor type.
 - 5. Condenser fans shall be arranged for vertical discharge of the condenser air, with manufacturer's standard wire guards.
- F. The wiring for each unit shall include:
 - 1. A crankcase heater (one per compressor).
 - 2. A 24-volt temperature control circuit.
 - 3. High and low pressure circuits.
 - 4. Condenser fan motor controls to assure stable operation of ambient temperatures down to 0 degrees F.
 - 5. Condenser fan and compressor contactors factory wired to pressure lugs or terminal block for power wiring.
 - 6. Factory mounted and wired fused disconnect switch.
- G. The refrigerant piping for each system shall include:
 - 1. A strainer-drier
 - 2. A moisture indicating sight glass
 - 3. Service access valves.
 - 4. Locking type, tamper resistance caps on all refrigerant access ports.

The strainer-drier and sight glass may be shipped separately for field installation.
- H. Manufacturers: York, Carrier, Trane, Daikin McQuay.
 - 1. Any listed equivalent manufacturer and the Mechanical Contractor shall be completely responsible to comply with all requirements on the contract documents. This shall include, but not be limited to, space requirements, code clearances, the type, horsepower, capacities, number and size of services required from other trades.

PART 3 – EXECUTION

3.1 REFRIGERATION EQUIPMENT

- A. All equipment to be installed in accordance with manufacturer's recommendations.

3.2 AIR-COOLED CHILLER

- A. Install in accordance with manufacturer's recommendations. Unit shall be properly supported and vibration isolated.
- B. Provide pipe insulation and jacketing over freeze protection electric heaters on all exterior water piping. Coordinate with the work of Division 26.

3.3 SPLIT SYSTEM HEAT PUMP/COOLING ONLY SPLIT SYSTEM

- A. Install split system units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.
- B. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory mounted.
 - 1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements. Do not proceed with equipment start-up until wiring installation is acceptable.

3.4 FIELD QUALITY CONTROL

- A. Start-up all units in accordance with manufacturer's start-up instructions. Replace damaged or malfunctioning controls and equipment.
- B. Manufacturer's Field Services
 - 1. Manufacturer shall furnish a factory trained service engineer without additional charge to start the unit(s). Representatives shall provide leak testing, evacuation, dehydration, and charging of the unit(s) as required. Chiller manufacturers shall maintain service capabilities to promptly respond within 24 hours or less to service calls at the site.
 - 2. A start-up log shall be furnished by the manufacturer to document the chiller's start-up date and shall be signed by the owner or his authorized representative prior to commissioning the chillers.
 - 3. The manufacturer shall furnish complete submittal wiring diagrams of the chiller(s) starter(s) and associated components such as pumps, interlocks, etc. as applicable.

END OF SECTION

SECTION 23 05 00**PIPING SYSTEMS & ACCESSORIES – HVAC****PART 1 – GENERAL****1.1 RELATED DOCUMENTS**

- A. The general provisions of the contract, including the conditions of the contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the work specified in this section.
- B. Refer to Section 230200 for HVAC General Provisions
- C. Refer to Section 230210 for HVAC Basic Materials & Methods.

1.2 DESCRIPTION OF WORK

- A. This Section includes the following equipment:
 - 1. In-Line Circulator Pumps
 - 2. Base-Mounted End Suction Pumps
 - 3. Suction Diffusers
 - 4. Diaphragm-Type Expansion Tanks (Vertical)
 - 5. High Efficiency Air Eliminator/Dirt Separator
 - 6. Water Feeders
 - 7. Relief Valve (Water Systems)
 - 8. Balancing Valves
 - 9. Combination Valve Package for Pumps
 - 10. Flexible Pump Connectors

1.3 REFERENCE STANDARDS

- A. Refer to Section 230200 for a general description of requirements applying to this section.

1.4 QUALITY ASSURANCE

- A. Refer to Section 230210 for a general description of requirements applying to this Section.
- B. Whenever a variable frequency PWM drive is installed to control an AC motor, a maintenance-free, circumferential, conductive micro fiber shaft grounding ring shall be installed on the AC motor drive end to discharge shaft currents to ground. Recommended part: AEGIS SGR™ Bearing Protection Ring, as made by Electro Static Technology. Install in accordance with the manufacturer's written instructions.

1.5 SUBMITTALS

- A. Submit shop drawings and product data in accordance with Section 230200.
- B. Submit the following:
 - 1. Shop Drawings
 - 2. Manufacturers Product Data
 - 3. Test Reports on Piping System Tests

1.6 SUBSTITUTIONS

- A. The listed equivalent or substituted manufacturers along with the bidding related contractor shall be completely responsible to comply with all requirements on all contract documents. This shall include, but not be limited to, space requirements, code clearances, the type, horsepower, capacities, number and size of services required from other trades, including all required ancillary items

furnished and installed by other trades. If the manufacturer or related bidding contractor does not comply with these requirements, this Contractor shall be responsible for any and all additional costs associated with the changes required by other trades.

1.7 WARRANTY/GUARANTEE

- A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, General Requirements.

PART 2 – PRODUCTS

2.1 IN-LINE CIRCULATOR PUMPS

- A. Provide in-line circulator pumps where indicated, and of capacities as scheduled.
- B. End suction with vertically split casing, close coupled, single stage, designed for 175 psi working pressure.
- C. Cast iron body, 125 psi ANSI flanges of equal size, tapings for gauge and drain fittings.
- D. Steel shaft with replaceable shaft sleeve and standard mechanical seal with ceramic seal seat.
- E. Enclosed type impeller hydraulically and dynamically balanced, keyed to shaft and secured with locking screw.
- F. Manufacturers: Subject to compliance with requirements, provide pumps of one of the following:
Armstrong Pumps
Aurora
Bell & Gossett
Ingersoll Rand
Peerless
Patterson
Paco
Taco

2.2 BASE-MOUNTED END SUCTION PUMPS

- A. Provide frame-mounted end suction pumps where indicated, and of capacities and having characteristics as scheduled.
- B. Horizontal mount, single stage, flexible coupling, base-mounted, designed for 175 psi working pressure.
- C. Cast iron casing 125 psi ANSI flanges, tapings for gauge and drain connections.
- D. Steel shaft with replaceable shaft sleeve, regreasable ball bearings and mechanical seals with carbon seal ring and ceramic seat.
- E. Non-overloading motor at any point on pump curve, open, drip-proof, ball bearings, 15,000 hours bearing life, with lifting lug on top of motor.
- F. Provide open drip-proof motor with regreasable ball bearings.
- G. Enclosed type impeller hydraulically and dynamically balanced, keyed to shaft and secured with locking screw.
- H. Structural steel baseplate with welded cross members, and open grouting area.
- I. Flexible coupling capable of absorbing torsional vibration, equipped with coupling guard.
- J. Manufacturers: Subject to compliance with requirements, provide pumps of one of the following:
Armstrong Pumps

Bell & Gossett

Aurora

Ingersoll Rand

Peerless

Patterson

Paco

Taco

2.3 SUCTION DIFFUSERS

- A. Provide at each base-mounted pump, a suction diffuser of size required for pump connection. Units shall consist of angle type body with straightening vanes and combination diffuser-strainer-orifice cylinder with 3/16" diameter openings for pump protection. A permanent magnet shall be located within the flow stream and shall be removable for cleaning. The orifice cylinder shall be equipped with a disposable fine mesh strainer which shall be removed after system start-up. Orifice cylinder shall be designed to withstand pressure differential equal to pump shutoff head and shall have a free area equal to five times cross section area of pump suction opening. Straightening vanes shall extend the full length of the orifice cylinder and shall be replaceable. Unit shall be provided with adjustable support foot to carry weight of suction piping.
- B. Manufacturers: by pump manufacturer.

2.4 DIAPHRAGM-TYPE EXPANSION TANKS (VERTICAL)

- A. Fabricate tank of continuously welded steel plate of the size shown conforming to ASME Section VIII Standards, maximum working pressure of 125 psi.
- B. Provide air charging valve, drain-offs, system connection and other piping connections. Paint outside of tank with a zinc chromate primer.
- C. Provide a standard cleanout hole located in the tank head.
- D. Tank shall have a sealed-in heavy-duty butyl diaphragm suitable for operation from 40 to 240 degrees F.
- E. Tank shall be furnished with an ASME stamp.
- F. The tanks shall be manufactured by Amtrol, Bell and Gossett, Patterson, Stover Tanks, Taco, Wheatley, John Wood.

2.5 HIGH EFFICIENCY AIR ELIMINATOR / DIRT SEPARATOR

Provide as shown on the drawings a combination full flow coalescing type high efficiency air eliminator / dirt and sediment separator on the hot and chilled water systems.

- A. All units shall be selected at the point of peak efficiency per the manufacturer's recommendations.
- B. Air eliminators / separators shall be fabricated steel, rated for 150 psig working pressure with entering velocities not to exceed 4 feet per second at specified GPM. Designated models specifically designed for high velocity systems may have an entering velocity of up to 10 feet per second.
- C. Vessel diameter shall be a minimum of two times pipe size. Vessel height above the nozzle center-line shall be a minimum of 3 times pipe size for standard units and 4.5 times pipe size for high velocity units. Vessel shall extend below nozzle center-line the same distance for dirt separation.
- D. Units shall include an internal bundle filling the entire vessel to suppress turbulence and provide high efficiency. The bundle shall consist of a copper core tube with continuous wound copper medium permanently affixed to the core. A separate copper medium shall be wound completely around and permanently affixed to each internal element.

- E. Each eliminator shall have a separate venting chamber to prevent system contaminants from harming the float and venting valve operation. At the top of the venting chamber shall be an integral full port float actuated brass venting mechanism.
- F. Units shall include a valved side tap to flush floating dirt or liquids and for quick bleeding of large amounts of air during system fill or refill.
- G. Unit shall include a blow down valve at bottom for removal of collected dirt and sediment.
- H. Air eliminator function shall be capable of removing 100% of the free air, 100% of the entrained air, and up to 99.6% of the dissolved air in the system fluid during continuous circulation.
- I. Dirt and sediment separator function shall be capable of removing 80% of particles 30 micron and larger within 100 passes. A properly selected strainer shall be installed upstream to collect large debris that may be left in the piping.
- J. (Optional) Provide removal head to facilitate internal element inspection or cleaning if required. Elements shall include tube sheets top and bottom and be manufactured as a bundle for ease of removal. Verify space required for bundle removal.
- K. Manufacturer: Spirovent®, Bell & Gossett, Taco.

2.6 WATER FEEDERS

- A. Each water circulating system shall have make-up water introduced through a pressure regulating valve provided with a three-valve bypass and a strainer.
- B. The pressure regulating valve shall be manufactured by McDonnell and Miller, A.W. Cash, Bell and Gossett.

2.7 RELIEF VALVE (WATER SYSTEMS)

- A. Each water circulating system of the closed type shall be provided with a pressure relief valve selected to suit the system heat generation capacity and set at 75 psig. Valves shall have casts bronze or cast steel body suitable for 250 PSIG and 450°F, stainless steel bushing, ring pin, and nickel alloy compression screw.
- B. This discharge from the relief valves shall be piped to a drain.
- C. Relief valves shall be manufactured by McDonnell and Miller, Bell and Gossett, A.W. Cash Company.

2.8 BALANCING VALVES

- A. Balancing valves shall be installed where indicated.
- B. Provide, as shown on the plans, balancing valves with provision for connecting a portable differential (Ft. of Head) pressure meter. Each meter connection shall have pressure/temperature readout ports.
- C. The balancing valves shall be either a bronze body/brass ball valve, or a Y-pattern globe valve style design and all metal parts of non-ferrous, pressure die-cast, nonporous Ametal copper alloy. Each valve can be installed in any direction without affecting flow measurement and shall provide four (4) functions:
 - 1. Precise flow measurement
 - 2. Precision flow balancing
 - 3. Positive shut-off with no drop seat and teflon disc
 - 4. Drain port suitable for hose bib fitting.
- D. The valves shall have four (4) 360 deg. adjustment turns of handwheel for maximum setting with hidden memory feature to program the valve with precision tamperproof balancing setting.

- E. Design Pressure/Temperature:
1/2" - 3" NPT connections 300 psig at 250 deg. F.
1/2" and 3/4" sweat connections 200 psig at 250 deg. F.
2" – 4" flanged or grooved connections 250 psig at 250 deg. F
4" flanged connections 175 psig at 250 deg. F.
- F. Flow sensor: For installation in piping 5" and larger, a precision wafer type orifice insert installed between standard 125 psi at 250 deg. F ANSI flanges to monitor system flow; cast iron body with integral brass EPT check valves to accommodate a differential pressure meter; furnish with calibrated nameplate with flow range through a range of differential head pressures; provide globe valve at each sensor to adjust flow to design conditions.
- G. Manufacturers: Tour & Andersson, Armstrong, Bell & Gossett, Nexus Valve, Taco, Victaulic, Wheatley.

OR

- A. Furnish and install, as shown on the plans, Balancing Valves with provisions for connecting a portable differential (Ft. of Head) pressure meter. Each meter shall have pressure/temperature probes.
- B. The balancing valves shall be Y-pattern globe style design and all metal parts of nonferrous, pressure die cast, nonporous Ametal. Each valve shall provide four (4) functions:
1. Precise flow measurement
 2. Precision flow balancing
 3. Positive shut-off with no drip seat, eliminating the need of as additional isolation valve
 4. Drain connection using 3/4" NPT hose end thread
- C. These valves shall have four (4) 360° adjustment turns of the handwheel for precise setting with hidden memory to provide a tamper-proof balancing setting. Handwheel shall have digital readout. The handwheel can be installed in any position without affecting performance.
- D. Connections shall be 1/2" to 2" NPT or solder end
- E. Manufacturers: Armstrong, Tour and Andersson, Wheatley, Nexus Valve, Vitaulic

OR

- A. Furnish and install, as shown on the plans, balancing valves with provisions for connecting a portable differential (Ft. of Head) pressure meter. Each meter connection shall have pressure / temperature probes.
- B. The balancing valves shall be Y-pattern globe style design with ductile iron body all other wetted parts of nonferrous, pressure die cast Ametal. Each valve shall provide (3) functions:
1. Precision flow measurement
 2. Precision flow balancing
 3. Shut-off feature, eliminating the need of an additional isolation valve
- C. These valves shall have eight (8), twelve (12), sixteen (16), twenty (20) or twenty-two (22) 360° adjustment turns of the handwheel for precise setting with hidden memory feature to program the valve with precision tamper-proof balancing setting. Handwheel shall have digital readout. The handwheel can be installed in any position without affecting performance.
- D. Connections shall be 2 1/2" and larger flanged or grooved ends.
- E. Manufacturers: Armstrong, Tour and Andersson, Wheatley, Nexus Valve, Vitaulic

2.9 COMBINATION VALVE PACKAGE FOR PUMPS

- A. Each centrifugal pump shall be provided with the following valve assemblies:
 - 1. Combination silent check valve, balancing valve and shut-off valve on pump discharge.
- B. The combination units shall be flanged assemblies of 125 lb. ASA Class, 175 psi. W.O.G. @ 300 degrees F. The combination units shall be suitable for vertical or horizontal installation with the stem pointing up.
- C. The body and bonnet shall be cast semi-steel; and the stem, seat and disc shall be bronze. The valve shall be designed for repacking under pressure.
- D. The unit shall be provided with a calibrated stem indicator, and the check valve shall have a stainless-steel spring and be provided with disc designed for quiet operation at low flow rates.
- E. Manufacturers: by Pump Manufacturer.

2.10 FLEXIBLE PUMP CONNECTORS

- A. Provide braided stainless-steel pump connector(s) manufactured with annular corrugated stainless steel close-pitch hose with stainless steel overbraid. The corrugated metal hose, braid(s), and a stainless-steel ring-ferrule/band (material gauge not less than .048") must be integrally seal-welded using a 100% circumferential, full-penetration TIG weld.
- B. End fittings shall be flat-face plate steel flanges with 150# ANSI drilling and outside diameter. Fittings must be attached using a 100% circumferential TIG weld. Braided stainless steel pump connector(s) must be suitable for operating temperatures up to 850°F. The rated working pressure of the braided metal hose must have a minimum 4:1 safety factor.
- C. Each braided stainless-steel pump connector shall be individually leak tested by the manufacturer using air-under-water or hydrostatic pressure. Flanged pump connectors shall be prepared for shipment using cut-to-length spacers, securely positioned between the flanges to prevent axial compression damage and maintain the manufactured length. Spacers must be removed prior to system start-up.
- D. Manufacturers: Amber/Booth, Flex-Hose Co., Inc., Mason Industries, Metra-Flex, Patterson, Proco Products, Inc., Twin City Hose, Inc.

PART 3 – EXECUTION

3.1 CIRCULATING PUMPS

- A. Pump shall be installed in accordance with recommendations of the Hydraulic Institute.
- B. Suction reducers shall be eccentric and located at the pump suction. Discharge increasers shall be concentric and located at the pump discharge.
- C. Suction and discharge piping shall be adequately supported without imposing any load on the pump casing.
- D. Pressure gauges shall be installed at the suction and discharge of each pump.
- E. Vibration isolation equipment shall be provided where noted.
- F. Impeller diameter used shall be approximately 85% of the maximum impeller diameter capable of being supplied for each pump.
- G. The motor nameplate horsepower shall not be exceeded under any conditions of pump operation.
- H. Prior to shipment, each pump shall be tested to insure its capability to produce the required capacity at the design head, and when requested written verification of this test shall be supplied.
- I. Before grouting and piping the pump, the Contractor shall check to insure pump alignment is satisfactory, and where required, realign the pump. Fill baseplate with non-shrink grout to the top of the base rail.

- J. Start-up service shall be provided by the pump manufacturer or his representative. This service shall include the following:
1. Check alignment
 2. Check absence of pipe strain
 3. Check lubrication
 4. Check rotation
 5. Take suction and discharge pressure gauge readings and compare with pump nameplate for operating head.
 6. Take voltage and current readings and compare with motor nameplate.
 7. Insure proper maintenance manuals are available if required.

3.2 PIPING SYSTEM DRAINS

- A. All piping shall be graded or pitched toward drain locations which shall be provided with gate valve unless otherwise indicated on drawings or specified. Individual risers may be drained through removable plugs or caps.
- B. Drain valves shall be provided at all major components in systems including boilers, pumps, heat exchangers, cooling towers, and similar equipment.

3.3 ECCENTRIC PIPE FITTINGS

- A. Eccentric pipe fittings shall be furnished and installed in all piping and circulated water piping where a change in pipe size occurs in a horizontal run. In water systems the top of the adjacent pipe sections shall be maintained level.

3.4 CHEMICAL CLEANING

- A. New boilers shall be boiled out with an alkaline type boiling out compound to remove grease, oil, mil scale and other foreign matter. The compound should be used at the rate of 1-1/2 pounds per 20 boiler horsepower. After the boiling out period, the boiler shall be completely drained, flushed and refilled with fresh water.
- B. Closed re-circulating systems shall be filled and sufficient detergent and dispersant added to remove all dirt, oil and grease. System shall be circulated for at least 48 hours after which a drain valve at the lowest point shall be opened and allowed to bleed while the system continues to circulate. The automatic make-up valve shall be checked to be sure it is operating. Bleeding shall continue until water runs clear and all detergent is removed. A sample of water shall be tested and if pH exceeds 8.0, draining should be resumed.
- C. Drain all detergent solution from system piping and equipment to nearest floor drain or indirect waste point connected to the building's sanitary system.

END OF SECTION

SECTION 23 05 10 WATER TREATMENT (HVAC)

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. The general provision of the contract, including the conditions of the contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the work specified in this section.
- B. Refer to Section 230200 for HVAC General Provisions.
- C. Refer to Section 230210 for HVAC Basic Materials & Methods.

1.2 DESCRIPTION OF WORK

- A. This Section includes labor, material, equipment and supervision to provide a complete water treatment system for the following:
 - 1. Cleaning and treatment of circulating HVAC chilled water system, hot water and steam system.
 - a. Cleaning Compounds.
 - b. Chemical Treatment for Closed Loop Systems.
 - c. Chemical Cleaning of New Systems

1.3 REFERENCE STANDARDS

- A. Refer to Section 230200 for a general description of requirements applying to this section.
- B. Requirements established within the portions of the Project Manual titled Division 1, General Requirements, are collectively applicable to the work of this section.
- C. Technical Services: Provide the services of an experienced water treatment chemical engineer or technical representative to direct flushing, cleaning, pre-treatment, training, debugging, and acceptance testing operations; direct and perform chemical limit control during construction period and monitor systems for a period of 24 months after acceptance, including not less than four service calls and written status reports.
- D. Field Quality Control and Certified Laboratory Reports: During the one-year guarantee period, the water treatment laboratory shall provide not less than 12 reports based on on-site periodic visits, sample taking and testing, and review with Owner, of water treatment control for the previous period. In addition to field tests, the water treatment laboratory shall provide certified laboratory test reports. These monitoring reports shall assess chemical treatment accuracy, scale formation, fouling and corrosion control, and shall contain instructions for the correction of any out-of-control condition.
- E. Provide two-year supply of preprinted water treatment test log forms.

1.4 SUBMITTALS

In accordance with Section 230200 provide the following:

- A. Manufacturer's Literature and Data:
 - 1. Cleaning compounds and procedures.
 - 2. Chemical treatment for closed systems.
- B. Water analysis verification.
- C. Materials Safety Data Sheet for all proposed chemical compounds.
- D. Maintenance and operating instructions.

PART 2 – PRODUCTS

2.1 CLEANING COMPOUNDS:

- A. Alkaline phosphate or non-phosphate detergent/surfactant/specifically to remove organic soil, hydrocarbons, flux, pipe mill varnish, pipe compounds, iron oxide, and like deleterious substances, with or without inhibitor, suitable for system wetted metals without deleterious effects.
- B. Refer to Section, PIPING SYSTEMS & ACCESSORIES - HVAC, PART 3, for flushing and cleaning procedures.

2.2 CHEMICAL TREATMENT FOR CLOSED LOOP SYSTEMS:

- A. Inhibitor: Provide sodium silicate, sodium nitrite/borate, or other approved proprietary compound suitable for make-up quality and make-up rate and which will cause or enhance bacteria/corrosion problems or mechanical seal failure due to excessive total dissolved solids. Shot feed manually. Maintain inhibitor residual as determined by water treatment laboratory, taking into consideration residual and temperature effect on pump mechanical seals.
- B. pH Control: Inhibitor formulation shall include adequate buffer to maintain pH range of 8.0 to 10.0.
- C. Performance: Protect various wetted, coupled, materials of construction including ferrous, and red and yellow metals. Maintain system essentially free of scale, corrosion, and fouling. Corrosion rate of following metals shall not exceed specified mills per year penetration; ferrous, 0.5; brass, 0.2; copper, 0.15. Inhibitor shall be stable at equipment skin surface temperatures and bulk water temperatures of, respectively, not less than 250- and 125-degrees Fahrenheit. Heat exchanger fouling and capacity reduction shall not exceed that allowed by fouling factor 0.0005.
- D. Pot Feeder: By-pass type for chemical treatment schedule 10 gauge heads, 3/4-inch system connections and large neck opening for chemical addition. Feeder shall be bypass filter feeder, minimum five gallon, installed per detail on the drawings, for chilled water system, and for hot water system.
- E. Water Analysis: Confirm raw water analysis or provide analysis if none is furnished.

Description	Year (Avg.)
Silica (SiO ₂)	_____
Insoluble	_____
Iron & Aluminum	_____
Calcium (Ca)	_____
Magnesium (Mg)	_____
Sodium & Potassium (Na & K)	_____
Carbonate (CO ₃)	_____
Bicarbonate (HCO ₃)	_____
Sulfate (SO ₄)	_____
Chloride (Cl)	_____
Nitrate (NO ₃)	_____
Turbidity	_____
pH	_____
Residual Chlorine	_____
Total Alkalinity	_____

Non Carbonate Hardness	_____
Total Hardness	_____
Dissolved Solids	_____
Fluorine	_____

F. Conduct performance test to prove capacity and performance of treatment system.

Raw water total hardness, ppm.

Concentration cycles.

Raw water, pH.

System water, pH.

Chemical solution used.

Acid solution used, obe.

Quantity of chemical solution injected into system per cycle.

Quantity of acid injected into system per cycle.

Make up water required.

Waste to drain requirement.

G. Recommended Conditions

1. Buffered Nitrite:

a. For temperatures 140°F to 180°F - 1000 ppm as sodium nitrite.

2. Molybdate:

a. 50 - 100 ppm as molybdate (chilled water).

3. pH - 7.0 to 10.0

2.3 CHEMICAL CLEANING OF NEW SYSTEMS

- A. Boil out boilers with an alkaline type boiling out compound to remove grease, oil, mill scale and other foreign matter. Compound should be used at the rate of 1-1/2 lbs. per 20 boiler HP. After boiling out period, completely drain, flush and refill boiler with fresh water.
- B. Fill closed recirculating systems and add sufficient detergent and dispersant to remove all dirt, oil and grease. Circulate system for at least 24 hours, after which open a drain valve at lowest point, open the make-up water valve and allow to bleed while system continues to circulate. Check the automatic make-up valve to be sure it is operating. Bleeding shall continue until water runs clear and all detergent is removed. Test sample of water and if pH exceeds the pH of the makeup water, flushing shall be resumed.
- C. Drain all detergent solution from system piping and equipment to nearest floor drain or indirect waste point connected to the building's sanitary system.

PART 3 – EXECUTION

3.1 INSTALLATION:

- A. Delivery and Storage: Deliver all chemicals in manufacturer's sealed shipping containers. Store in designated space and protect from deleterious exposure and hazardous spills.
- B. Install equipment furnished by the chemical treatment supplier and charge systems according to the manufacturer's instructions and as directed by the Technical Representative.
- C. Perform tests and report results.
- D. Instruct owner personnel in system maintenance and operation.

3.2 INSPECTIONS AND MAINTENANCE:

- A. Furnish complete inspection and maintenance service on water treatment equipment for a period of two years after completion and acceptance of the water treatment equipment installation.
- B. The maintenance service shall include the following:
 - 1. Monthly systematic examination of equipment.
 - 2. Cleaning, lubricating, adjusting, repairing and replacing of all parts as necessary to keep the equipment in first-class condition and proper working order.
 - 3. Furnishing all lubricant, cleaning materials and parts required.
 - 4. The operational system shall be maintained to the manufacturer's standards specified including any changes and/or adjustments required to meet varying conditions.
 - 5. Provide 24-hour emergency call-back service which shall consist of promptly responding to calls within two hours for emergency service should a shutdown or emergency trouble develop between regular examinations. Overtime emergency call-back shall be limited to minor adjustments and repairs required to protect the immediate safety of the equipment.
 - 6. Service personnel shall report to the owner or his authorized representative upon arrival and again upon completion of the required work. A copy of the work ticket containing a complete description of the work performed shall be given to the owner.
 - 7. The Contractor shall maintain a log in the boiler room. The log shall list the date and time of all monthly examinations and all trouble calls. Each trouble call shall be fully described including the nature of the call, necessary correction performed and/or parts replaced.

END OF SECTION

SECTION 23 06 00**AIR DISTRIBUTION & ACCESSORIES – HVAC****PART 1 – GENERAL****1.1 RELATED DOCUMENTS**

- A. The general provisions of the contract, including the conditions of the contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the work specified in this section.
- B. Refer to Section 230200 for HVAC General Provisions
- C. Refer to Section 230210 for HVAC Basic Materials & Methods.
- D. This Contractor shall coordinate with the work of Division 26 and the Fire Alarm System vendor for locations and mounting of all duct smoke detectors. These devices are shown on the Mechanical Drawings for reference only to show the intent of the work. All locations shall be determined based on approved shop drawings from the Fire Alarm System vendor and the Contractor for the work of Division 26, Electrical. Mount smoke detectors in the supply and return air stream at each unit in accordance with NFPA 72.

1.2 DESCRIPTION OF WORK

- A. This Section includes labor, material, equipment and supervision to provide a complete air distribution system as specified herein and as shown on drawings.
 - 1. Ductwork – Single Wall, Square and Rectangular
 - 2. Ductwork - Single Wall, Spiral Round
 - 3. Flexible Air Duct
 - 4. Flexible Connections
 - 5. Dampers
 - 6. Fire Dampers
 - 7. Air Diffusers, Registers and Grilles
 - 8. Prefabricated Roof Curbs and Equipment Supports
 - 9. Sound Attenuation
 - 10. Duct Access Doors (Interior)
 - 11. Fabric Air Dispersion Ductwork
 - 12. Roof-Mounted Intake Ventilator
 - 13. Remote Operated Balancing Damper

1.3 REFERENCE STANDARDS

- A. Refer to Section 230200 for a general description of requirements applying to this section.
- B. Requirements established within the portions of the Project Manual titled Division 1, General Requirements, are collectively applicable to the work of this section.
- C. IMC (International Mechanical Code).
- D. SMACNA (Sheet Metal and Air Conditioning Contractors National Association, Inc.)
- E. American Society of Heating, Refrigerating and Air Conditioning Engineers' recommendations in ASHRAE Guide shall apply to this work.
- F. ARI Standard 885 - Standard for Estimating Occupied Sound Levels in the Applications of Air Terminals and Air Outlets.

- G. UL (Underwriter's Laboratories, Inc.)
- H. NFPA 90A and 96 shall apply to this work.
- I. State Fire Prevention Regulations.
- 1.4 QUALITY ASSURANCE
 - A. Refer to SECTION 230210 for a general description of requirements applying to this Section.
- 1.5 SUBMITTALS
 - A. Submit shop drawings and product data in accordance with Section 230200.
 - B. Submit the following:
 - 1. Shop drawings of all sheet metal. Indicate all steel, piping, conduit, and Architectural/Structural features to demonstrate complete coordination. Scale shall not be less than 1/4".
 - a. Shop drawings shall indicate the sizes and lengths of each section of ductwork as well as all system components such as coils, access doors, dampers, diffusers and register locations. Also indicate the type of joints used and where internal acoustic lining or insulation, if required, will be utilized.
 - b. The location of the duct runs and the air outlets shall be closely coordinated with all other trades by the sheet metal contractor to avoid interference. The shop drawings shall show the contact surfaces adjacent to the ducts or air outlets and the space assigned for concealment. The drawings shall indicate principal items of equipment, adjacent piping and conduit, etc., the location of which shall be secured from the contractors of other trades.
 - c. Sheet Metal Contractor to include resubmissions of the shop drawings to the Engineer. The resubmissions are to include all corrections to previous submissions.
 - 2. Manufacturer's literature and performance data of all equipment and devices.
 - 3. Samples: Furnish color samples, etc., at request of the Architect.
- 1.6 SUBSTITUTIONS
 - A. The listed equivalent or substituted manufacturers along with the bidding related contractor shall be completely responsible to comply with all requirements on all contract documents. This shall include, but shall not be limited to space requirements, code clearances, the type, horsepower, capacities, number and size of services required from other trades, including all required ancillary items furnished and installed by other trades. If the manufacturer or related bidding contractor does not comply with these requirements, they shall be responsible for any and all additional costs associated with the changes required by other trades.
- 1.7 WARRANTY GUARANTEE
 - A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, General Requirements.

PART 2 – PRODUCTS

- 2.1 DUCTWORK (SINGLE WALL, SQUARE AND RECTANGULAR)
 - A. All ductwork shall be fabricated in accordance with SMACNA "HVAC Duct Construction Standards - Metal and Flexible" latest Edition except as described below. The minimum thickness of metal ductwork is 26 gauge. Fabrication requirements shall be based on ductwork subjected to positive or negative pressures of 4" W.G. Ductwork systems shall be sealed to SMACNA "Seal Class "A" Standards. Alternatively, "Ductmate" System 45 can be used in accordance with manufacturer's specifications. Drive slip joints are not permitted.

Exception: For ductwork smaller than 12" x 8", Contractor may provide slip and drive joints with all joints sealed with Hardcast tape and mastic system.

- B. Rectangular ducts for 4" W.G. or less, positive or negative pressure shall be per SMACNA Table 1-7. Longitudinal seams shall be Pittsburgh Lock Type L-1 per SMACNA Figure 1-5. Transverse joints shall be standing seam type T -15 per Figure 1-4.
 - 1. In the event that material size is not compatible with duct size and segmenting must be utilized to fabricate duct, use SMACNA Figure 1-5, seam L-4 (Standing Seam).
 - C. Joints:
 - 1. Per SMACNA Transverse Joint Reinforcement Table 1-12, only joints T -22, T -25a, T -25b and Proprietary slip-on flanges will be acceptable.
 - 2. Joints T -25a and T -25b that have stress fractures from bending will not be accepted.
 - 3. All joints will have butyl gasket 3/16" thick by 5/8" wide installed per manufacturers installation instructions.
 - D. Ductwork systems for this standard shall be galvanized sheet steel, commercial quality of lock - forming grade, conforming to ASTM coating standards A-525 or A-527 with coating of designation G-60. For corrosive or moist conditions, use coating designation G-90.
 - 1. Where the outer surface of the duct is exposed in finished spaces and is not scheduled for insulation, duct material shall be galvanized, suitable for field painting by the General Contractor.
 - E. The size and configuration of each duct shall be indicated on design drawings. Where thicker sheets or different types of materials are required, they shall be specified on the design drawings or in the project specifications.
 - F. Aluminum Rectangular Ductwork:
 - 1. Aluminum ductwork shall be two B.& S. gauges heavier than specified for the equivalent width steel ductwork. Bracing, supports and joints shall be as specified for steel ductwork.
 - 2. Aluminum ducts shall be used where the ducts are concealed when exhausting saturated air from dishwashing, showers, outside air intakes and similar designated spaces.
 - 3. Dishwashing exhaust ducts shall be made watertight by means of silicone or 3M duct sealant properly installed and compressed at each joint and seam.
 - G. Kitchen exhaust duct shall have all joints, seams, penetrations and duct-to-hood collar connections with continuous, external, liquid-tight welds.
 - 1. Carbon Steel: Fabricate from 16-gauge, ASTM-A569 hot rolled or ASTM-A366.
 - 2. Stainless Steel: Fabricate from 18-gauge, Type 304, 2D finish.
- 2.2 DUCTWORK (SINGLE WALL, SPIRAL ROUND)
- A. Design Pressure: 2"
 - B. Leakage: All ductwork shall meet SMACNA Class "A" leak standards.
 - C. Fabrication:
 - 1. Gauges, reinforcing angles, seams, joints, fabrication methods, installation methods and practices, duct reinforcement, fabricated dampers and devices installed in duct system, fittings, etc., shall conform to the latest editions of SMACNA standards for construction in accordance with requirements indicated in these specifications.
 - 2. Minimum metal gauges shall be 26 gauge (.019). Follow SMACNA Table 3-2A for Positive pressure and Table 3-2B for Negative pressure.

3. Where the outer surface of the duct is exposed in finished spaces and is not scheduled for insulation, duct material shall be galvanized, suitable for field painting by the General Contractor.

D. Joints:

1. Duct up to 36" diameter - Male/Female beaded slip joint similar to SMACNA Figure 3-2, joint RT-1 or RT-5, as long as it meets the criteria for the system design pressure. Fittings shall be undersized to fit into spiral duct. All joints shall be secured with a minimum of 4 screws on each duct section (equally spaced). Seal joint with an approved sealant compound, continuously applied prior to assembly of joint and after fastening, making certain that the majority of the sealant resides on the interior of the joint.
2. In lieu of beaded slip, there are proprietary connections that may be used, as long as they meet the pressure criteria set forth in this specification.

2.3.a FLEXIBLE AIR DUCT

- A. Insulated flexible air duct shall be non-metallic. Air duct shall comply with the latest NFPA Bulletin No. 90A and be labeled as Class 1 Air Duct, U.L. Standard No. 181.
- B. Air ducts shall be suitable for working pressure of not less than plus 10.0 and minus 0.5 inches of W.G.
- C. Non-metallic air duct shall be two element spiral construction composed of a corrosion resisting metal supporting spiral and a vinyl coated fiberglass base fabric and shall be mechanically interlocked together.
- D. Insulation shall be 1-1/2" thick fiberglass flexible blanket with vapor barrier outer jacket of polyethylene or reinforced mylar. Maximum thermal conductance of 0.23 Btu/Hr./SF/Inch at 75 deg. F temperature.
- E. Where flex elbow connections are made to diffusers, provide a flexible duct elbow support (durable elbow support). Support shall be a 1-piece, fully adjustable radius forming brace and be UL listed. Manufacturer shall be Thermaflex Flex-Flow, Titus Flex-Right, or approved equal.
- F. Approved manufacturers shall include the Wiremold Company, Flexmaster USA, Owens-Corning, Thermaflex Flex Vent.

2.3.b ACOUSTICAL FLEXIBLE AIR DUCT (Theater, Black Box Theater, Band, Orchestra, Chorus, and other Music Rooms)

- A. Core material shall be an acoustical spun bond nylon fabric 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 2½ 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 5,500 feet per minute.
- D. Suitable for operating temperatures of at least 250°F.
- E. Minimum Acoustic Performance:
 1. The insertion loss (dB) of a 9-foot length of duct when tested in accordance with ASTM E 477 at a velocity of 2,500 feet per minute shall be at least:

	125 Hz	250 Hz	500 Hz	1,000 Hz	2,000 Hz	4,000 Hz
1) 8-inch dia.	27	27	32	33	37	33
2) 12-inch dia.	24	23	30	31	37	25

- F. Insulation shall be fiberglass flexible blanket with metalized vapor barrier, rated for R6.
- G. Where flex elbow connections are made to diffusers, provide a flexible duct elbow support (durable elbow support). Support shall be a 1-piece, fully adjustable radius forming brace and be UL listed. Manufacturer shall be Thermaflex Flex-Flow, Titus Flex-Right, or approved equal.
- H. Manufacturer: Flexmaster USA

2.4 FLEXIBLE CONNECTIONS

- A. Required between ductwork and suction and discharge connection of all fans and air handlers.
- B. Material: Woven fiberglass with mounting hardware tested in accordance with UL Standard 181, listed and labeled as Class 0 or 1.
- C. Manufacturer: Ventfabrics, Inc., Durodyne, Dynair, Ductmate Pro Flex.

2.5 DAMPERS

- A. Provide where indicated and required to control flow of air and balance system.
- B. Round dampers shall be single blade, molded synthetic bearings at each end, 20-gauge galvanized steel, adjusting quadrant and locking device. Round dampers shall be Ruskin Model MDRS25.
- C. Rectangular and square dampers shall be opposed blade within 16-gauge galvanized steel channel frame with corner brace, 16-gauge galvanized steel blades; molded synthetic bearings and hex steel shafts, exposed or concealed linkage, adjustable quadrant and locking device. Dampers 10" and below shall be single-blade. Dampers shall be Ruskin Model MD35.
- D. Branch dampers installed within acoustical lined ductwork shall be opposed blade, framed type (not shop fabricated).
- E. Approved Manufacturers: Ruskin, Arrow, Nailor-Hart, Pottorff, Lloyd Industries, Inc., Cesco Products, Louvers & Dampers, United Enertech.

2.6 FIRE DAMPERS

- A. Fabricate in accordance with NFPA 90A and UL 555.
 1. Ceiling Dampers: Galvanized steel, 22-gauge frame and 16-gauge flap, two layers 0.125-inch ceramic fiber on top side with locking clip.
 2. Horizontal Dampers: Galvanized steel, 22-gauge frame, stainless steel closure spring, and lightweight, heat retardant, non-asbestos fabric blanket.
 3. Curtain Type Dampers: Galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for closure under air flow conditions. Configure with blades out of air stream except for 1.0-inch pressure class ducts up to 12 inches in height.
 4. Multiple Blade Dampers: 16-gauge galvanized steel frame and blades, oil-impregnated bronze or stainless-steel sleeve bearings and plated steel axles, 1/8 x 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops and lock.
 5. Fusible Links: UL 33, separate at 160 deg. F with adjustable link straps for combination fire/balancing dampers.
- B. Fire dampers of the applicable rating shall be provided at all locations where ductwork penetrates fire-rated walls, ceilings, or floors. Refer to Architectural Drawings.
- C. Manufacturers: Air Balance, Inc., Ruskin, Louvers & Dampers, Prefco, Phillips-Aire, Metalaire, Pottorff, Lloyd Industries, Inc., Cesco Products, Greenheck, United Enertech.

2.7 AIR DIFFUSERS, REGISTERS AND GRILLES

- A. Air diffusing terminals shall be provided in duct runs on drawings. The diffusers shall properly and uniformly distribute the design air quantity with no objectionable drafts, while maintaining not more than 50 F. P. M. velocity in the occupied portion of the space.
- B. Ceiling Diffusers:
 - 1. Square Louvered Diffuser Face:
 - a. Square housing, welded steel construction core of square concentric louvers, removable at face of diffuser, round duct connection, with borders suitable for lay-in ceiling tile application.
 - b. Diffuser Patterns: Fixed louver face for 1, 2, 3, or 4 direction air flow, direction indicated on drawings.
 - c. Finish: Matte white finish.
 - d. Manufacturers: Krueger Model SH-SHR
 - 2. Linear Diffusers:
 - a. Linear diffusers shall be horizontal continuous slot type with multiple slots per the schedule and drawings. Construction shall be extruded aluminum with 1/2", 3/4" or 1 " slots. The diffusers shall have integral devices to equalize air flow over the entire length of the diffuser.
 - b. Multiple sections of diffusers shall be installed in a continuous arrangement, the butt ends shall be provided without flanges to provide a continuous effect. Multiple sections shall be aligned and fastened with alignment pins and slots or a similar method.
 - c. Linear diffusers shall be provided with adjustable vanes to provide horizontal, vertical or midway patterns of air diffusion. Finish as selected by Architect.
 - d. Krueger Model 1900
 - 3. Round Cone Diffusers:
 - a. Fully adjustable round cone diffuser, welded steel construction with round neck and removable inner assembly of cones.
 - b. Air pattern shall be field adjustable from full horizontal to full vertical.
 - c. Finish: Matte white finish
 - d. Krueger Model RA2
 - 4. Linear Bar Grille
 - a. The linear bar grille shall be constructed of extruded aluminum with 1/8" thick fixed bars at 15 deg deflection and 1/4" or 1/2" spacing.
 - b. The linear bar core shall be locked to the extruded aluminum frame with fixed deflection bars running parallel to the longest dimension.
 - c. The finish shall be white and be an anodic acrylic paint, with a pencil hardness of HB to H.
 - d. Krueger Model 1500 or 1600.
 - 5. Linear Slot Diffuser
 - a. Linear slot diffuser shall be available with slot widths of 1" – 3".
 - b. Slot diffusers lengths greater than single piece lengths shall be furnished in multiple sections joined together with alignment strips to form a continuous slot appearance.
 - c. Blank off pieces shall be available to be installed between active sections as indicated.

- d. Vertical throw deflectors shall be two piece extruded aluminum construction.
 - e. The linear diffuser shall be white or black with all other surfaces including pattern controller shall be black. Final color selection by Architect.
 - f. Krueger Model DFL10-VT.
- C. Registers & Grilles:
- 1. Registers and grilles shall be steel construction, fixed single deflection type, with clips and/or flange holes and screws (as required by Architectural finishes) to secure registers to ceiling construction. Face bars shall be inclined 30 degrees. Registers and grilles shall be factory primed and painted with a baked-on white enamel finish.
 - 2. Wall Supply Registers:
 - a. Provide manufacturer's standard wall registers where shown; of size, shape, capacity, type of materials and components indicated.
 - b. Register Materials: Steel construction: Manufacturer's standard stamped sheet steel frame and adjustable blades.
 - c. Register Faces: Horizontal Straight Blades, individually adjustable, at manufacturer's standard spacing.
 - d. Register Patterns: Double Deflection: 2 sets of blades in face, rear set at 90 degrees to face set.
 - e. Register Finishes: Aluminum Enamel: Air-dried aluminum enamel prime finish.
 - 3. Supply Grilles (SG):
 - a. Aluminum supply grilles shall be available parallel to the long dimension of the grille. All supply grilles shall be constructed with a 1 1/4-inch-wide heavy aluminum border having a minimum thickness of 0.040-0.050 inch. Outer borders shall be assembled and interlocked at the four corners and mechanically staked to form a rigid frame. Screw holes shall be countersunk for a neat appearance.
 - b. Blades shall be constructed of heavy-duty aluminum and shall be contoured to a specifically designed airfoil cross-section to meet published performance data. Where indicated in drawing schedule or plans opposed-blade volume damper shall be constructed of heavy gauge steel or aluminum.
 - c. The finish shall be #26 white. The finish shall be a baked on anodic acrylic paint, with a pencil hardness of HB to H.
 - d. Krueger Model AF5880
 - 4. Ceiling Return Grille (CR):
 - a. Ceiling grilles shall have a perforated face with 3/16-inch diameter holes on 1/4-inch staggered centers and no less than 51 percent free area. Perforated face shall be aluminum according to the model selected. The back pan shall be one piece stamped heavy gauge steel of the sizes and mounting types shown on the plans and outlet schedule.
 - b. The finish shall be #26 white. The finish shall be a baked on anodic acrylic paint, with a pencil hardness of HB to H. Inside of back pan shall be painted flat black.
 - c. Krieger Model 6490
 - 5. Return, Exhaust and Transfer Grilles (RG, EG & TG):
 - a. Grilles shall be available parallel to the long dimension of the grille. Construction shall

- be of steel with a 1 1/4-inch-wide border on all sides. Screw holes shall be countersunk for a neat appearance. Corners shall be welded with full penetration resistance welds.
 - b. Deflection blades shall be firmly held in place by mullions from behind the grille and fixed to the grille by welding in place. Blade deflection angle shall be available at 35°.
 - c. The finish shall be #26 white. The finish shall be a baked on anodic acrylic paint, with a pencil hardness of HB to H.
 - d. Krueger Model S85
6. Heavy-Duty Return Grille
- a. Grille shall be 45-degree deflection fixed louver type with blades spaced 3/4" on center.
 - b. The outlet shall have 14-gauge steel blades and heavy duty steel support bars and frames.
 - c. Blades shall run parallel to the long dimension of the grille.
 - d. The finish shall be #B12 white. The finish shall be a baked on anodic acrylic paint.
7. Ceiling Louvered Return Filter Grille (CR):
- a. Return filter grilles shall be of size and mounting type as shown on the drawings and schedules.
 - b. Borders shall be constructed of steel with countersink holes or frame suitable for ceiling finish in each room.
 - c. The four corners shall be interlocked and mechanically staked to form a rigid frame.
 - d. Deflection blades shall be 1/2 inch spacing, 45° deflection.
 - e. Return grilles shall be provided with a filter frame that will accommodate a standard 1-inch-thick disposable filter to fit the specified duct size. Filter shall be grille module size minus 4 inches. Filter capacity shall be as scheduled on the drawings.
 - f. Return grille finish shall be white powder coat.
 - g. Krueger Model S85 w/ filter frame
8. Linear Bar Grille
- a. Extruded aluminum construction with 1/8" thick fixed bars at 0 or 15 degree deflection spaced on 1/4" or 1/2" centers.
 - b. Units longer than 72" shall be provided in multiple sections and assembled with alignment strips from manufacturer for a continuous linear appearance.
 - c. The finish shall be #44 British White. The finish shall be a baked on anodic acrylic paint, with a pencil hardness of HB to H.
 - d. Krueger Model 1600.
- D. Manufacturers: Provide diffusers, registers and grilles of one of the following:
- | | |
|------------|-------------------|
| Anemostat | Price |
| Carnes Co. | Titus |
| Krueger | Tuttle & Bailey |
| Metalaire | Nailor Industries |
- 2.9 PREFABRICATED ROOF CURBS AND EQUIPMENT SUPPORTS
- A. Factory fabricated by the manufacturer of the respective roof-mounted equipment when available and capable of meeting the following requirements:
- 1. Thermally and acoustically insulated, rubber isolating pads.

2. Built to suit slope of roof and type of roofing; i.e. standing metal seam with integral cant strip and flashing extension.
 3. 12" height unless otherwise indicated.
 4. Support rails shall be aluminum, or sheet steel, with continuous wood nailer and removable counterflashing.
- B. Curbs shall be a product of a custom manufacture in the following cases:
1. Curbs as specified are not available from the respective equipment manufacturer.
 2. Piping or ducts penetrating roof.
 3. Prefabricated equipment supports are required.
 4. Step flashing assembly, EPDM for normal use and silicone for pipe temperatures above 200°F stainless steel clamp, suitable for single or multiple pipes.
- C. Pipe supports shall be a product of a custom manufacture equal to Pipe Prop as made by JMB Industries, or Anvil International Haydon H-Block.
- D. Manufacturers: Pate, Shipman, Custom Curb, Portals Plus, Lloyd Industries, Inc.
- 2.10 SOUND ATTENUATION
- A. Provide silencers of the types and sizes shown on plans.
- B. Materials and Construction:
1. Outer casings of rectangular silencers shall be made of 22-gauge galvanized steel in accordance with ASHRAE Guide recommended construction for high pressure rectangular duct work. Seams shall be lock formed and mastic filled.
 2. Outer casings of tubular silencers shall be made of galvanized steel.
 3. Interior partitions for rectangular silencers shall be made of not less than 26 gauge galvanized perforated steel.
 4. Interior construction of tubular silencers shall be compatible with the outside casings.
 5. Filler material shall be of inorganic mineral or glass fiber of a density sufficient to obtain the specified acoustic performance and be packed under not less than 5 % compression to eliminate voids due to vibration and settling. Material shall be inert, vermin and moisture-proof.
 6. Combustion rating for the silencer acoustic fill shall be not less than the following when tested in accordance with ASTM-E-84, NFPA Standard 255 or UL No. 723:

Flamespread Classification	25
Smoke Development Rating	15
Fuel Contribution	20
 7. Airtight construction shall be provided by use of a duct sealing compound on the job site. Material and labor furnished by contractor. Silencers shall not fail structurally when subjected to a differential air pressure of 8 in. w.g. inside to outside of casing.
- C. Acoustic Performance: Silencer ratings shall be determined in a duct- to-reverberant room test facility which provides for airflow in both directions through the test silencer in accordance with ASTM Specification E-477. The test set-up and procedure shall be such that all effects due to end reflection, directivity, flanking transmission, standing waves and test chamber sound absorption are eliminated. Acoustic ratings shall include Dynamic Insertion Loss (DIL) and Self- Noise (SN) Power Levels both for Forward Flow (air and noise in same direction) and Reverse Flow (air and noise in opposite directions) with airflow of at least 2000 fpm entering face velocity.

- D. Aerodynamic Performance: Silencer shall be of the low static pressure loss type. Airflow measurements shall be made in accordance with ASTM specification E-477 and applicable portions of ASME, AMCA and ADC airflow test codes. Tests shall be reported on the identical units for which acoustic data is presented.
 - E. Certification: With submittals, the manufacturer shall supply certified test data on Dynamic Insertion Loss, Self-Noise Power Levels, and Aerodynamic Performance for Reverse and Forward Flow test conditions. Test data shall be for a standard product. All rating tests shall be conducted in the same facility, shall utilize the same silencer, and shall be open to inspection upon request from the Architect/Engineer.
 - F. Manufacturers: Industrial Acoustics Co., Rink, Commercial Acoustics, Dynasonics, BRD, Pottorff, Vibro-Acoustics, Price.
- 2.11 DUCT ACCESS DOORS (Interior Locations)
- A. SMACNA standard duct access doors shall be fabricated with 22-gauge galvanized steel door and frame with double wall construction.
 - 1. Doors shall be fabricated of aluminum when installed in aluminum ductwork and stainless steel to match special duct systems.
 - B. Continuous piano type hinge, same material as door.
 - C. Latches shall be sash type locks equal to Ventlock 100 latches.
 - 1. Doors 16" and under shall have one latch.
 - 2. Doors over 16" shall have two latches.
 - D. Door seals shall be foam gasket material continuously bonded to perimeter of door frame.
 - E. Door insulation shall be 1" thick fiberglass, minimum 1.5 pcf density.
 - F. Doors shall be able to withstand 3" W.C. static pressure up to 12" x 12" in size; 2" W.C. above that size.
 - G. Makes: Cesco Products, Karp Co., Nailor-Hart Industries, Pottorff, Lloyd Industries, Inc., Ductmate Industries, Inc.
- 2.12 FABRIC AIR DISPERSION DUCTWORK
- A. Product shall be constructed of a coated woven fire-retardant fabric complying with the following physical characteristics:
 - 1. Type: Verona
 - 2. Configuration: Standard: round
 - 3. Fabric Construction: Plain polyester weave.
 - 4. Coating: Porous.
 - 5. Weight: 5.2 oz. per square yard.
 - 6. Permeability: 2 cfm per square foot @ 0.5" WC
 - 7. Color: Standard color as selected by the Architect
 - 8. Warranty: 5 years on products for the fabric system
 - 9. Temperature Range: 0 degrees F to 180 degrees F
 - 10. Fire Retardancy: Classified by Underwriters Laboratories in accordance with the 25/50 flame spread/smoke developed requirements of NFPA 90-A.

B. Systems Fabrication Requirements:

1. Air dispersion accomplished by round vent, and consist of open orifices rather than a mesh style vent to reduce maintenance requirements (common to mesh style).
2. Size of and location of vents shall be specified and approved by manufacturer.
3. Inlet connection to metal duct via fabric draw band with anchor patches supplied by manufacturer. Anchor patches shall 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 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. Fabric system shall include connectors to accommodate suspension system listed below.
9. Any deviation from a straight run shall be made using a gored elbow or an efficiency tee. Normal 90-degree elbows are 5 gores and the radius of the elbow is 1.5 times the diameter of the DuctSox.

C. Design Parameters:

1. Fabric air diffusers shall be designed from 0.25" water gage minimum to 3.1" maximum, with 0.5" as the standard.
2. Fabric air diffusers shall be limited to design temperatures between 0 degrees F and 180 degrees F.
3. Design CFM, static pressure and diffuser length shall be designed and approved by the manufacturer.
4. Do not use fabric diffusers in concealed locations.
5. Use fabric diffusers only for positive pressure air distribution components of the mechanical ventilation system.

D. Suspension Hardware:

1. Internal Hoop System: Provide a factory fabricated retention system consisting of an internal 360° hoop system spaced on maximum 5' centers. Each hoop shall be fabricated of lightweight aluminum ring and tubing with negligible effect on airflow static resistance. The rings located at the inlet and end of run shall include tensioning anchor clips to secure the fabric to the hoop system. Sizes shall include 8" to 36" diameter in 2" increments. The system shall be installed with a one row suspension system located 1.5" above top dead center of the fabric duct system. System attachment shall be either cables or u-track using gliders spaced 12" on center.

E. Manufacturer: Duct Sox by Fabric Air Dispersion Products, Fabric Air Inc., or KE Fibertec.

2.13 ROOF-MOUNTED INTAKE VENTILATORS

- A. Heavy gauge spun aluminum construction.
- B. Aluminum base with continuously welded curb cap corners.
- C. Aluminum insect screen.
- D. Provide 12-inch-high insulated roof curb with blocking to secure equipment.
- E. Manufacturers: Penn Ventilator Co., Carnes Co., Greenheck, Loren-Cook or Acme.

2.14 REMOTE OPERATED BALANCING DAMPER

- A. Damper system shall be suitable for either round or rectangular ductwork installations.
 - 1. Provide where indicated on the drawings and required to control the flow of air and balance the system.
 - 2. Damper rated for +30°F to 125°F, maximum velocity = 2000FPM.
 - 3. Differential pressure rating: 2 in. W.C.
- B. Rectangular dampers shall be 20 ga. galvanized steel blades with 22 ga. galvanized steel channel frame and braced corners.
 - 1. Galvanized steel side plate for mounting damper drive mechanism.
 - 2. Opposed blade design, self-lubricated synthetic bearings.
 - 3. 3/8" square drive shaft.
 - 4. Plenum rated wiring with DC power connector routed to wall plate.
- C. Round dampers shall be 20 ga. Galvanized steel with rolled bead stiffeners.
 - 1. Blades shall be reinforced with self-lubricated bearings.
 - 2. Standoff bracket for mounting damper drive mechanism.
 - 3. 3/8" square drive shaft.
 - 4. Plenum rated wiring with DC power connector routed to wall plate.
- D. UL classified battery powered universal damper drive, factory mounted to damper. Provide cable extensions as required in 10, 20, 30, or 50 ft. increments to suit job conditions with M-F RCA connectors up to 150 ft. maximum continuous length.
- E. Provide single or multiple connector wall plate for convenient access to damper adjustment, location as shown on the drawings. Provide any/all extension power cables with battery powered hand-held controller for ease of adjustment from wall mounted terminal plate.
- F. Approved manufacturers: Metropolitan Air Technology, Zipset System as made by The Zip Group, LLC, Pottorff.

PART 3 – EXECUTION

3.1 DUCTWORK

- A. Dimensions on drawings are inside dimensions. Sheet metal dimensions shall be increased to suit thickness of acoustic duct lining, if applicable. Ductwork that is lined with acoustic lining is not insulated.
- B. Ducts shall be concealed unless otherwise indicated.
- C. Changes in direction shall be made with radius bends or turning vanes.
- D. Supports shall be galvanized steel (min. 18 GA) for steel ductwork and aluminum for aluminum ductwork.
- E. Locate ceiling air diffusers, registers, and grilles on "Reflected Ceiling Plans". Unless otherwise indicated, locate units in center of acoustical ceiling modules.
- F. Do not install ductwork directly above any electrical equipment.
- G. Ductwork shall be supported per SMACNA Standards except as follows:
 - 1. Rivet or screw to side of duct when using flat strap hangers. Rivet or screw to bottom of duct when using trapeze hangers.
 - 2. Extend hangers down the side of the duct at least 9"; pass hangers under ducts less than 9" deep.

3. Space hangers not more than 8' on centers for ducts up to 18" wide and 4' on centers for ducts over 18" wide.
4. Wire/Cable hangers are not acceptable.
5. Support ductwork independently from building structure with expansion bolts, rods, steel angles or channels installed to meet existing or new building conditions. Do not support from other ductwork.
6. Drilling into the roof deck is not permitted.
7. Driving nails into anchors is not permitted.

H. Air Flow Control:

1. Major take-offs: Install volume control dampers.
2. Branches: Install volume control dampers in all branches and at tap in branch take-off connections.
3. Elbows: Use unvaned elbows with throat radius equal to width of duct and full heel radius; provide turning vanes where full throat and heel radius are not possible.
4. Transitions: Make transitions in ducts as required by structural or architectural interferences.
 - a. Proportion airways to compensate for any obstructions within duct.
 - b. Avoid dead ends and abrupt angles.
 - c. Do not exceed 15 degrees slope on sides of transitions.

3.2 FLEXIBLE AIR DUCT

- A. When flexible duct is used for final connection between duct mains on branches and diffusers on registers. The maximum length of flexible ductwork shall be 5'-0" in length.
- B. Flexible ductwork shall be properly hung at the tap collar in order to prevent eventual wear and damage to the flexible duct.
- C. The ceiling tile system should not be considered a support on which to lay flexible duct. Refer to SMACNA Standards for proper installation.

3.3 DUCT SYSTEM LEAK SEALING

- A. Joints in duct systems at duct heaters, fire dampers, sound traps, and supply air terminals shall be sealed to prevent air leakage.
- B. All duct joints and seams in medium pressure and high-pressure duct systems shall be sealed to SMACNA Seal Class "A" Standards to prevent air leakage.
- C. In the event there is in excess of 5% air leakage indicated in low pressure duct systems, it shall be the Contractors responsibility to seal the duct system. The amount of sealing necessary shall be that required to obtain the design air quantity at each terminal.
- D. Duct sealing shall be by means of high velocity duct sealants such as Hardcast and/or Neoprene gaskets. Type of sealant and method of application shall conform to recommendations in SMACNA high velocity duct construction standards.

3.4 DUCTWORK TESTING

- A. The following ductwork shall be pressure leak tested:
 1. Supply ductwork
 2. Return ductwork
 3. Exhaust ductwork
 4. Outside air intake ductwork

5. Kitchen hood exhaust duct
- B. Pressure leak test the following:
 1. All ductwork within chases
 2. 15% of all ducts
 3. 100% of all major equipment (ERUs, RTUs, AHUs, EFs, etc.)
 4. 10% of all equipment (FCUs, HPs, etc.)
- C. All tests shall be conducted in accordance with AABC National Standards.
- D. Ducts to be tested at 100% maximum of static pressure before any duct is insulated externally and concealed in accordance with SMACNA Standards.
- E. Calculate the allowable leakage using leakage factor of 5% of Design Air Flow.
- F. Select a limited section of duct for which the estimated leakage will not exceed capacity of the test apparatus.
- G. Connect the blower and flow meter to the duct section and provide temporary seals at all openings of the ductwork.
- H. Start the blower motor with the inlet damper closed. Increase pressure until the required level is reached.
- I. Read the flow meter and compare the leakage in cfm. Reading should be 5% or less of design flow for the duct segment being tested.
- J. If reading is more than 5% of design flow, depressurize duct, repair all leaks and retest until 5% or less of design flow is obtained.
- K. Complete test reports and obtain Owner's witness signature.
- L. Remove all temporary blanks and seals.
- M. Warning: Do not overpressure duct.

3.5 EQUIPMENT

- A. Test apparatus shall consist of an airflow measuring device, flow producing unit, pressure indicating devices and accessories necessary to connect the metering system to the test specimen.
- B. The Contractor conducting tests shall arrange for or provide all temporary services, all test apparatus, all temporary seals and all qualified personnel necessary to conduct the specified testing.
- C. Test apparatus shall be accurate within plus or minus 7.5% at the indicated flow rate and test pressure and shall have calibration data or a certificate signifying manufacture of the meter in conformance with the ASME Requirements for Fluid Meters. Verification of above, to be supplied to Owner upon request.
- D. Pressure differential sensing instruments shall be readable to 0.05" scale division for flow rates below 10 cfm or below 0.5" w.g. differential. For flows greater than 10 cfm scale divisions of 0.1" are appropriate. U-tube manometers should not be used for reading less than 1" of water.
- E. Liquid for manometers shall have a specific gravity of 1 (as water) unless the scale is calibrated to read in inches of water contingent on use of a liquid of another specific gravity, in which case the associated gauge fluid must be used.
- F. Instruments must be adjusted to zero reading before pressure is applied.

3.6 TEST REPORT

- A. Log the project and system identification data.
- B. Enter the fan CFM, the test pressure, and the leakage class specified by the designer.

- C. Enter an identification for each duct segment to be tested.
 - D. Calculate the allowable leakage factor. Enter this number on the report for each test segment.
 - E. Conduct and record the field tests. If the sum of the CFM measured is less than or equal to the sum of the allowable leakage, the test is passed. Record the date(s), presence of witnesses and flow meter characteristics.
 - F. Maintain a mechanical duct plan of all tested duct segments. Plan to include duct segment identification and dates tested.
 - G. Test reports shall be submitted as required by the project documents.
- 3.7 LABELING

- A. At all fire damper locations, access doors in ductwork shall be identified with a permanent placard of red-white-red laminated commercial grade plastic construction, minimum one-half inch high capital letters, reading, "FIRE DAMPER" as appropriate for the installation. Attach securely to face of access door with brass screws at each corner, sealed airtight.

END OF SECTION

SECTION 23 06 05**FANS****PART 1 – GENERAL****1.1 RELATED DOCUMENTS**

- A. The general provisions of the contract, including the conditions of the contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the work specified in this section.
- B. Refer to Section 230200 for HVAC General Provisions
- C. Refer to Section 230210 for HVAC Basic Materials & Methods.

1.2 DESCRIPTION OF WORK

- A. This Section includes labor, material, equipment and supervision to provide a complete air distribution system as specified herein and as shown on drawings.
 - 1. Roof-Mounted Exhaust Fans
 - 2. Vertical Discharge exhaust Fan (Kitchen)
 - 3. Direct Drive Centrifugal Square Inline
 - 4. Recessed Ceiling Fan
 - 5. Utility Set
 - 6. Centrifugal Vent Set Lab Exhaust Blower

1.3 REFERENCE STANDARDS

- A. Refer to Section 230200 for a general description of requirements applying to this section.
- B. Requirements established within the portions of the Project Manual titled Division 1, General Requirements, are collectively applicable to the work of this section.
- C. IMC (International Mechanical Code)
- D. SMACNA (Sheet Metal and Air Conditioning Contractors National Association, Inc.)
- E. American Society of Heating, Refrigerating and Air Conditioning Engineers' recommendations in ASHRAE Guide shall apply to this work.
- F. UL (Underwriter's Laboratories, Inc.)
- G. NFPA 90A and 96 shall apply to this work.
- H. State Fire Prevention Regulations.

1.4 QUALITY ASSURANCE

- A. Refer to Section 230210 for a general description of requirements applying to this Section.
- B. Whenever a variable frequency PWM drive is installed to control an AC motor, a maintenance-free, circumferential, conductive micro fiber shaft grounding ring shall be installed on the AC motor drive end to discharge shaft currents to ground. Recommended part: AEGIS SGR™ Bearing Protection Ring, as made by Electro Static Technology. Install in accordance with the manufacturer's written instructions.

1.5 SUBMITTALS

- A. Submit shop drawings and product data in accordance with Section 230200.
- B. Submit the following:
 - 1. Shop drawings of all sheet metal. Indicate all steel, piping, conduit, and Architectural/Structural features to demonstrate complete coordination. Scale shall not be less than 1/4" = 1'-0".

2. Manufacturer's literature and performance data of all equipment and devices.

1.6 SUBSTITUTIONS

- A. The listed equivalent or substituted manufacturers along with the bidding related contractor shall be completely responsible to comply with all requirements on all contract documents and as described within the specifications. This shall include, but shall not be limited to space requirements, code clearances, the type, horsepower, capacities, number and size of services required from other trades, including all required ancillary items furnished and installed by other trades. If the manufacturer or related bidding contractor does not comply with these requirements, they shall be responsible for any and all additional costs associated with the changes required by other trades.

1.7 WARRANTY/GUARANTEE

- A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, General Requirements.

PART 2 – PRODUCTS

2.1 ROOF MOUNTED EXHAUST FANS – BELT DRIVE

- A. Fan shall be a spun aluminum, roof mounted, belt driven, down blast centrifugal exhaust fan.
- B. Fan shall be constructed of minimum 16-gauge marine alloy aluminum, bolted to a rigid aluminum support structure. The motor, bearings, and drives shall be mounted to a steel assembly, isolated with rubber vibration isolators.
- C. Unit shall have an engraved nameplate indicating fan number, CFM, static pressure, and maximum fan RPM at a minimum.
- D. Wheel shall be centrifugal, backwards inclined.
- E. Motor shall be NEMA design B with class B insulation rated for continuous duty.
- F. Bearings shall be constructed of heavy duty re-greaseable ball type in a cast iron pillow block housing.
- G. Drives shall be sized for 150 percent of installed motor horsepower.
- H. Accessories: Disconnect switch, insulated roof curb, speed controller, and belt tensioner. Curb to match roof configuration (flat, sloped, raised -seam, etc.).
- I. Manufacturers: Penn Ventilator Co., Greenheck, Loren Cook, Captive-Aire.

OR

2.1 ROOF MOUNTED EXHAUST FAN – DIRECT DRIVE

- A. Fan shall be a spun aluminum, roof mounted, direct driven, down blast centrifugal exhaust fan.
- B. Fan shall be constructed of minimum 16-gauge marine alloy aluminum, bolted to a rigid aluminum support structure. The motor shall be enclosed in a weather-tight compartment, separated from the exhaust air stream.
- C. Unit shall have an engraved nameplate indicating fan number, CFM and static pressure at a minimum.
- D. Wheel shall be centrifugal, backwards inclined.
- E. Motor shall be NEMA design B with class B insulation rated for continuous duty.
- F. Motor shall be an electronically communicated motor rated for continuous duty and furnished with internally mounted potentiometer speed controller or with leads for connection to 0-10 VDC external controller.
- G. Accessories: Disconnect switch, insulated roof curb, and speed controller. Curb to match roof configuration (flat, sloped, raised -seam, etc.).
- H. Manufacturers: Penn Ventilator Co., Greenheck, Loren Cook, Captive-Aire.

2.2 VERTICAL DISCHARGE EXHAUST FAN (KITCHEN)

- A. The exhaust fan shall be a vertical discharge, roof-mounted, power ventilator with heat, vapor and fume resistant features.
- B. The casing shall consist of base curb cap, ventilated motor compartment, and upper and lower exterior wind bands. The casing shall be of mill finish aluminum of spun construction.
- C. Fan wheel shall be centrifugal backward curved type constructed of aluminum. Back plate of fan wheel shall be finned to provide forced cooling of the motor compartment.
- D. An insulated heat shield shall separate the ventilated motor compartment from the air stream, and a shaft seal shall prevent seepage of heat and fumes from around the shaft into the motor compartment.
- E. The fan shaft shall be motor driven through a V-belt drive which shall be adjustable by varying the pitch diameter of the motor pulley. The drive shall be provided with a safety factor equal to 150% of the motor ampere nameplate rating. Provision shall be made for adjusting the V- belt tension.
- F. A disconnect safety switch shall be mounted under the removable motor dome. The fan motor shall have copper windings.
- G. The fan shall be provided with a bird guard constructed of stainless-steel expanded metal.
- H. Provision shall be made in the unit design for ready access for cleaning and for serving all components and accessories. Provide hinged curb cap with stay brace to fit onto curb.
- I. An integral grease trough shall be provided on the fan base for applications on Type I kitchen ventilators, as well as a vented curb extension.
- J. Special motors for high heat and explosion-proof shall be provided where indicated in the schedule.
- K. The exhaust fan unit shall be AMCA certified and shall be as manufactured by Penn Ventilator Company, Loren Cook, Acme, Greenheck, Twin City Fans.

2.3 DIRECT DRIVE CENTRIFUGAL SQUARE INLINE

- A. Fan shall be duct mounted, direct driven centrifugal square inline.
- B. Fan shall be manufactured at an ISO 9001 certified facility. Fan shall be listed by Underwriters Laboratories (UL 7605). Fan shall bear the AMCA certified ratings seal for sound and air performance.
- C. The fan shall be bolted construction utilizing corrosion resistant fasteners. Housing shall be minimum 18-gauge galvanized steel with integral duct collars. Bolted access doors shall be provided on three sides, sealed with closed cell neoprene gasketing. Unit shall bear an engraved aluminum nameplate. Nameplate shall indicate design CFM and static pressure.
- D. Wheel shall be centrifugal backward inclined, constructed of 100% aluminum, including a precision machined cast aluminum hub. Wheel inlet shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA standard 204-05, balance quality and vibration levels for fans.
- E. Motor shall be NEMA design B with a minimum of class B insulation rated for continuous duty and furnished at the specified voltage, phase, and enclosure.
- F. Manufacturer: Loren Cook, Greenheck, Penn Ventilator.

2.4 RECESSED CEILING FAN

- A. Recessed ceiling fan shall consist of a rectangular steel cabinet enclosing a true centrifugal fan directly driven by an electric motor.
- B. Cabinet shall be complete with a finished aluminum grille and discharge collar equipped with a backdraft damper, metal or plastic, gravity or spring return.
- C. Motor and fan shall be conveniently removable with plug-in power chord.

- D. The casing shall be sound attenuated, with minimum ½” thick acoustic lining.
- E. Provide electronic speed controller, roof curb & cap, and isolator package.
- F. Unit shall be AMCA certified.
- G. Manufacturers: Loren-Cook, Penn Ventilator, Acme, Carnes, Greenheck, Breidert, Panasonic, Twin City Fans.

2.5 UTILITY SET

- A. Fan shall be a single width, single inlet, backward inclined flat blade, belt driven centrifugal vent set.
- B. Fan shall be manufactured at an ISO 9001 certified facility. Fan shall be listed by Underwriters Laboratories (UL/cUL 705) for US and Canada. For restaurant applications, fan shall be listed by Underwriters Laboratories (UL/cUL 762) for US and Canada. Fan shall bear the AMCA certified ratings seal for air performance.
- C. The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The scroll wrapper shall be a minimum 14-gauge steel and the scroll side panels shall be a minimum 12-gauge steel. The entire fan housing shall have continuously welded seams for leakproof operation. A performance cut-off shall be furnished to prevent the recirculation of air in the fan housing. The fan housing shall be field rotatable to any one of eight discharge positions and shall have a minimum 1-1/2” outlet discharge flange. Bearing support shall be minimum 10-gauge welded steel. Side access inspection ports shall be provided with quick release latches for access to the motor compartment without removing the weather cover. Lifting lugs shall be provided for ease of installation. Unit shall bear an engraved aluminum nameplate. Nameplate shall indicate design CFM, static pressure, and maximum fan RPM.
- D. Steel fan components shall be coated with an electrostatically applied, baked polyester powder coating. Paint must exceed 1,000 hour salt spray under ASTM B117 test method.
- E. Wheel shall be steel centrifugal backward inclined, non-overloading flat blade type. Blades shall be continuously welded to the backplate and deep spun inlet shroud. Wheel hub shall be keyed and securely attached to the fan shaft. Wheel inlet shall overlap an aerodynamical aluminum inlet cone to provide maximum performance and efficiency.
- F. Motor shall be NEMA design B with Class B insulation rated for continuous duty and furnished at the specified voltage, phase, and enclosure.
- G. Bearings shall be designed and tested specifically for use in air handling applications. Construction shall be heavy duty regreasable ball or roller type in a cast iron pillow block housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.
- H. Belts shall be oil and heat resistant, static conducting. Drives shall be precision machined cast iron type, keyed and securely attached to the wheel and motor shafts. Drives shall be sized for 150% of the installed motor horsepower. The variable pitch motor drive must be factory set to the specified fan RPM.
- I. Accessories: Refer to schedule.
- J. Manufacturer: Loren Cook, Greenheck, Penn Ventilator.

2.6 CENTRIFUGAL VENT SET LAB EXHAUST BLOWER

- A. Unit consisting of a fan, curb cap, inlet box and high velocity muzzle shall be a single width, single inlet, backward inclined flat blade, belt driven centrifugal vent set laboratory exhaust blower.
- B. Unit shall be manufactured at an ISO 9001 certified facility. Fan shall be listed by Underwriters Laboratories (UL/cUL 705) for US and Canada. Unit shall bear the AMCA certified ratings seal for sound and air performance (AMCA certification complete with muzzle and inlet box installed).

Build-up field fabricated systems or manufacturer provided accessories not installed during AMCA testing are not acceptable.

- C. The unit shall be of bolted and welded construction utilizing stainless steel fasteners. The scroll wrapper shall be a minimum 14-gauge steel and the scroll side panels shall be a minimum 12-gauge steel. The entire fan housing shall have continuously welded seams for leakproof operation. The adjustable nozzle is positioned to generate the designed outlet velocity. The integral cap and inlet box is intended to be used for curb mounting with bottom intake roof duct connections. Inlet box shall include gasketed access door with quick release latches to allow wheel and inlet removal. Bearing support shall be minimum 10-gauge welded steel. Side access inspection ports shall be provided with quick release latches for access to the motor compartment without removing the weather cover. The fan housing shall have a door for wheel access and threaded drain connection. Unit shall bear an engraved aluminum nameplate. Nameplate shall indicate design CFM, static pressure, and maximum fan RPM.
- D. Steel fan components shall have phenolic epoxy with UV top coating electrostatically applied baked powder. Paint must exceed 1,000 hour salt spray under ASTM B117 test method.
- E. Wheel shall be steel centrifugal backward inclined, non-overloading flat blade type. Blades shall be continuously welded to the backplate and deep sun inlet shroud. Wheel hub shall be keyed and securely attached to the fan shaft. Wheel inlet shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency.
- F. Motor shall be NEMA design B with Class B insulation rated for continuous duty and furnished at the specified voltage, phase, and enclosure.
- G. Bearings shall be heavy duty regreasable ball or roller type in a cast iron pillow block housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.
- H. Blower shaft shall be AISI 316 stainless steel and accurately turned, ground and polished. Shafting shall be sized for a critical speed of at least 125% of maximum RPM.
- I. Belts shall be oil and heat resistant, static conducting. Drives shall be precision machined cast iron type, keyed and securely attached to the wheel and motor shafts. Drives shall be sized for 150% of the installed motor horsepower. The variable pitch motor drive must be factory set to the specified fan RPM.
- J. Accessories: Refer to schedule
- K. Manufacturer: Loren Cook, Greenheck, Penn Ventilator.

PART 3 – EXECUTION

3.1 FANS, EQUIPMENT AND ACCESSORIES

- A. Install in accordance with manufacturer's details and instructions.
- B. Mount fan speed control at the fan to facilitate mechanical balancing. Power wiring shall be part of the work of Division 26.
- C. Perform field mechanical balancing in accordance with Section 230950: TESTING AND BALANCING OF MECHANICAL SYSTEMS.
- D. Install units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.
- E. Support: Install and secure roof curb structure, in accordance with National Roofing Contractor's Association (NRCA) installation recommendations and shop drawings. Install and secure units on curbs and coordinate roof penetrations and flashing.

- F. The Mechanical Contractor shall own as a part of his work, the following:

Provide one (1) additional drive set, if necessary, to obtain final design balancing requirements. The Mechanical Contractor shall coordinate with Balancing Firm and equipment manufacturer for drive selection, including belts and pulleys.

END OF SECTION

SECTION 23 07 25

TERMINAL HEATING UNITS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the contract, including the conditions of the contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the work specified in this section.
- B. Refer to Section 230200 for HVAC General Provisions
- C. Refer to Section 230210 for HVAC Basic Materials & Methods.

1.2 DESCRIPTION OF WORK

- A. This Section includes work necessary and/or required and materials and equipment for construction of a complete system. Such work includes, but is not limited to the following:
 - 1. Unit Heaters
 - 2. Cabinet Heaters
 - 3. Hot Water Coils
 - 4. Steel Radiators
 - 5. Electric Cabinet Unit Heater
 - 6. Electric Wall Heater
 - 7. Electric Steel Panel Baseboard

1.3 REFERENCE STANDARDS

- A. Refer to Section 230200 for a general description of requirements applying to this section.

1.4 QUALITY ASSURANCE

- A. Refer to Section 230210 for a general description of requirements applying to this Section.

1.5 SUBMITTALS

- A. Submit shop drawings in accordance with Section 230200.
- B. Submit shop drawings and descriptive data for all equipment specified in this section.

1.6 SUBSTITUTIONS

- A. The listed equivalent or substituted manufacturers along with the bidding related contractor shall be completely responsible to comply with all requirements on all contract documents. This shall include, but not limited to, space requirements, code clearances, the type, horsepower, capacities, number and size of services required from other trades, including all required ancillary items furnished and installed by other trades. If the manufacturer or related bidding contractor does not comply with these requirements, this Contractor shall be responsible for any and all additional costs associated with the changes required by other trades.

1.7 WARRANTY/GUARANTEE

- A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, General Requirements.

PART 2 – PRODUCTS

2.1 UNIT HEATERS

- A. Propeller type, direct drive, resilient-mounted motor, arranged for horizontal discharge, double-deflection louvers.

- B. Tested at 400 psig hydrostatic and 200 psig air under water.
- C. Enclosure shall be steel, cleaned, phosphated, primed and finished in baked enamel.
- D. Manufacturers: Airtherm Manufacturing Co., Modine, Rittling, Sterling, Trane, Vulcan.

2.2 CABINET HEATERS

- A. Provide cabinet heaters including chassis, heating elements, fans, motor and insulation.
- B. Chassis: Galvanized steel wraparound structural frame with edges flanged.
- C. Insulation: Faced, heavy density glass fiber.
- D. Cabinet: Vertical semi-recessed/recessed/surface-mounted model as scheduled on the drawings, 16 gauge four sided overlap front panel with stiffeners. Clean cabinet parts, bonderize, phosphatize, and flow-coat with baked-on primer.
- E. Coils: Aluminum fins, copper tubes, mechanically expanded for a permanent bond. Provide manual air vent.
- F. Grilles: Intake and outlet grilles shall be integral, stamped 15 degrees deflection.
- G. Fans: Provide direct drive centrifugal, forward curved double width fan.
- H. Motors: Provide two-speed permanent split capacitor type motors (or variable speed) with integral overload protection and motor cords for plug-in to junction box in unit.
- I. Provide HI/LO/OFF fan control (concealed).
- J. Manufacturers: Airtherm Manufacturing Co., Modine, Rittling, Sterling, Trane, Vulcan, Sigma.

2.3 HOT WATER COILS

- A. Provide coils of size and in location indicated, and of capacities and having performance data as scheduled. Certify coil capacities, pressure drops and selection procedures in accordance with AHRI 410.
- B. Construct fins of continuous aluminum configured plate-fin type with full fin collars for accurate spacing and maximum fin-tube contact.
- C. Construct tubes of 5/8" or 1/2" seamless copper tubing, .025" nominal wall thickness, arranged in parallel pattern with respect to airflow.
- D. Construct headers of gray cast iron. Hydrostatically test to 400 psi before assembly.
- E. Construct casings of 14-gauge continuous coated galvanized steel with formed end supports and top and bottom channels.
- F. Proof test coils at 300 psi, leak test at 200 psi under water.
- G. Manufacturers: Carrier, York/Johnson Controls, The Coil Co., Trane, USA Coil.

2.4 STEEL RADIATORS

- A. Provide steel radiators fabricated from cold rolled low carbon steel, fully welded and consisting of header pipes at each end, connected by flat oval water tubes.
- B. Tube thickness shall be 0.048" minimum wall thickness. Header pipes shall be square 0.109" minimum wall thickness and include all necessary supply, return, and air vent connections.
- C. Piping connects shall be 1/2" NPT taper threaded sockets, located in the vertical position. Air vent connection shall be 1/8" NPT taper threaded sockets.
- D. Minimum working pressure shall be 56psi max tested at 74psi.
- E. Radiators expansion shall not exceed 0.016" per linear foot at 215F.

- F. Radiators shall be cleaned and phosphatized for final factory powder coat finish. Color of the finish paint shall be selected by the Architect from the manufacturer's standard color chart included with equipment submittals.
- G. Wall mounting brackets shall be furnished with each section of radiator on manufacturer's required centers for proper support of each section.
- H. Contractor shall provide required shielded anchor fasteners compatible with existing masonry walls. Coordinate with details shown on the Architectural drawings.
- I. Sizes, capacities, and quantities shall be provided as shown on the drawings and schedule.
- J. Manufacturer: Runtal Radiators as made by Runtal North America, Inc., Rittling, Sigma.

2.5 ELECTRIC CABINET HEATERS

- A. Provide cabinet heaters including chassis, heating elements, fan and motor designed for either recessed mounting within ceiling grid, or wall-mounted.
- B. Chassis: Galvanized steel wraparound structural frame with edges flanged.
- C. Power disconnect switch.
- D. Cabinet: Horizontal recessed model, heavy gauge, four sided overlap front panel with stamped steel louver air openings. Clean cabinet parts, phosphatize and coat with baked-on enamel finish. Color: white (Final color selection by Architect).
- E. Coils: Steel fins, copper brazed, for a permanent bond to low watt density, steel sheathed tubular heating elements.
- F. Grilles: Intake and outlet grilles shall be integral, stamped 15 deg. Deflection in ceiling trim ring.
- G. Fans: Provide direct drive, five bladed aluminum.
- H. Motors: Provide single speed impedance protected, totally enclosed motor with integral overload protection and motor cords to junction box in unit.
- I. Provide built-in fan delay control and automatic thermal cutout.
- J. Manufacturers: Q-Mark, Berko, TPI/Markel, Indeeco, Electromode.

2.6 ELECTRIC WALL HEATERS

- A. The heating element shall be of the non-glowing design consisting of a special resistance wire enclosed in a steel sheath to which steel plate fins are copper blazed. It shall be warranted for 5 years.
- B. Fan shall be five-bladed aluminum. Fan motor shall be totally enclosed.
- C. Fan control shall be of bi-metallic, snap-action type and shall activate fan after heating element reaches operating temperature. The fan shall continue to operate after the thermostat is satisfied and until the heating element is cool.
- D. The tamper-proof thermostat shall be of the bi-metallic snap-action type with enclosed contacts. It shall be completely concealed behind the front cover to become tamper proof.
- E. A manual-reset thermal cutout shall be built into the system to shut off the heater in the event of overheating.
- F. A double-pole, single throw ON/OFF switch shall be mounted on the back box for positive disconnect of power supply.
- G. The back box shall be designed for duty as a recessed rough-in box in either masonry or frame installations. The back box shall be 20-gauge galvanized steel and shall contain knockouts through which power leads are brought.
- H. The front panel shall be of the bar grille type and shall be constructed of 18-gauge cold-rolled steel, welded into a uniform grille to direct the warmed air toward the floor.

- I. Manufacturers: Q-Mark, Berko, Marley, Indeeco, TPI/Markel.

2.7 ELECTRIC STEEL PANEL BASEBOARD

- A. Provide electric steel panel radiant panels of lengths and in locations as indicated, and of capacities, as scheduled. The floor-mounted heating panel radiation shall be of heavy gauge steel construction, consisting of flattened heat dispersion tubes welded to stiffening tubes at each end, interior heat mats and corrugated fins for heat dispersal. The electric radiant panel shall include an integral heavy gauge (0.09" minimum) all-welded perforated top grille.
- B. The heating elements shall be available as 208-volt configuration. Electric junction boxes at either end of the panel can be used for wiring of the panel. Electric radiant panels shall have UL and CUL listing.
- C. The electric radiant heating panels shall be available in lengths from 3'0" to 10'0" in one-foot increments without the need to splicing.
- D. The panel radiation shall be finish painted with a gloss powder coat finish. The color shall be selected by Owner or Architect.
- E. The floor mounted pedestal accessory shall be of heavy gauge welded steel construction. Powder coat finish shall match heater.
- F. Manufacturers: Runtal North America or approved equal.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which equipment is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF UNIT HEATERS

- A. Install heaters in accordance with manufacturer's installation instructions.
- B. Uncrate units and inspect for damage. Verify that nameplate data corresponds with unit designation.
- C. Hang unit from building substrate.
- D. Protect units with protective covers during balance of construction.

3.3 INSTALLATION OF CABINET HEATERS

- A. Install cabinet heaters in accordance with manufacturer's installation instructions.
- B. Locate cabinet heaters as shown on the drawings. Coordinate with other trades.
- C. Protect units with protective covers during balance of construction.

3.4 DUCT HEATING COILS

- A. Install in accordance with manufacturer's recommendations.
- B. Coil casing dimensions shall not be less than approach duct dimensions.
- C. Comb fins if damaged. Install safing to eliminate air bypass or leakage at coil sections.

3.5 STEEL RADIATORS

- A. Handle and install units in accordance with manufacturer's written instructions.
- B. Support units rigidly so they remain stationary at all times. Crossbracing or other means of stiffening shall be provided as necessary. Method of support shall be such that distortion and mal-operation of units cannot occur.
- C. Installed height shall be in accordance with manufacturer's recommendations.
- D. Enclosures shall be run continuously, wall-to-wall, or as indicated on drawings.

3.6 INSTALLATION OF ELECTRIC HEATERS

- A. Install heaters in accordance with manufacturer's installation instructions.
- B. Uncrate units and inspect for damage. Verify that nameplate data corresponds with unit designation.
- C. Hang unit from building substrate.
- D. Protect units with protective covers during balance of construction.
- E. Perform field mechanical balancing in accordance with Section 230950: TESTING AND BALANCING OF MECHANICAL SYSTEMS.

END OF SECTION

SECTION 23 07 60
AIR HANDLING EQUIPMENT

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the contract, including the conditions of the contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the work specified in this section.
- B. Refer to Section 230200 for HVAC General Provisions
- C. Refer to Section 230210 for HVAC Basic Materials & Methods.

1.2 DESCRIPTION OF WORK

- A. This Section includes work necessary and/or required and materials and equipment for construction of a complete system. Such work includes, but is not limited to the following:
 - 1. Fan – Coil Air Handling Unit
 - 2. Air Handling Unit (Modular, Sectional Type)
 - 3. Heating and Ventilation Unit
 - 4. Packaged Air-To-Air Energy Recovery Unit
 - 5. Packaged Rooftop HVAC Unit with Energy Recovery
 - 6. Single Packaged Gas-Fired Rooftop Air Conditioning Unit
 - 7. Packaged Gas-Fired Rooftop Unit (Kitchen Ventilation)

1.3 REFERENCE STANDARDS

- A. Refer to Section 230200 for a general description of requirements applying to this section.
- B. AMCA Standards 210 and 300 for fans.
- C. ARI Standard 410, ASHRAE Standard 33 for Heating and Cooling Coils.
- D. ASHRAE Standard 52.2 and U.L. Standard 900 for media type air filters.
- E. AMCA Standard 511 and 500D for Air Control Dampers.
- F. ARI Standard 1060 and ASHRAE Standard 84 for Air-to-Air Energy Recovery Equipment.
- G. ARI Standard 260 and 430 for Air Handling Units.

1.4 QUALITY ASSURANCE

- A. Refer to Section 230210 for a general description of requirements applying to this Section.
- B. Whenever a variable frequency PWM drive is installed to control an AC motor, a maintenance-free, circumferential, conductive micro fiber shaft grounding ring shall be installed on the AC motor drive end to discharge shaft currents to ground. Recommended part: AEGIS SGR™ Bearing Protection Ring, as made by Electro Static Technology. Install in accordance with the manufacturer's written instructions.

1.5 SUBMITTALS

- A. Submit shop drawings in accordance with Section 230200.
- B. Submit shop drawings and descriptive data for all equipment specified in this section.
- C. Submit all relevant sound power data, including inlet, discharge, and case radiated noise. All sound data should be sound power levels in octave bands. This information will be reviewed by the Acoustic Consultant.

1.6 SUBSTITUTIONS

- A. The listed equivalent or substituted manufacturers along with the bidding related contractor shall be completely responsible to comply with all requirements on all contract documents. This shall include, but not limited to, space requirements, code clearances, the type, horsepower, capacities, number and size of services required from other trades, including all required ancillary items provided by other trades. If the manufacturer or related bidding contractor does not comply with these requirements, this Contractor shall be responsible for any and all additional costs associated with the changes required by other trades.

1.7 WARRANTY/GUARANTEE

- A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, General Requirements. In addition, the following special guarantee applies:
 - 1. Each compressor unit shall be provided with manufacturer's five (5) year parts and labor warranty.

PART 2 – PRODUCTS

2.1 FAN – COIL AIR HANDLING UNIT

- A. General:
 - 1. Install each unit as shown on the plans in accordance with: The Manufacturer's recommendations, and all applicable national and local codes.
 - 2. UL approved.
 - 3. Covered by a 2-year limited parts warranty on the complete unit.
 - 4. In current production with published literature available to check performance, limitations, specifications, power requirements, dimensions, operation and appearance.
- B. Unit Enclosure:
 - 1. Exterior panels of minimum 18-gauge galvanized steel that have been finished with baked enamel to provide a long-lasting, quality appearance. Casing shall be insulated with ½" thick fiberglass, max k-value of 0.24 fire resistant and odorless material.
 - 2. Removable panels to provide easy access to the internal components for maintenance and service.
 - 3. A filter rack with space to accommodate 1" throwaway, pleated filters, 30% standard MERV 8 efficiency, flat or angled arrangement with end covers. Provide one spare filter for each unit for Owner's stock. (NOTE: Units served with filter return grilles do not require final filter in unit. Provide panel to seal filter opening.)
 - 4. All concealed units shall have 1-1/4" discharge duct collar, 1" on return.
 - 5. Fan coil units shall be mounted with spring vibration isolators with static deflection of min. 0.75"..
 - 6. There shall be a minimum of 4'-0" straight duct between fan coil unit and first take-off or elbow.
- C. Fans shall be double-width, forward-curved.
- D. ECM Motors:
 - 1. All motors shall be brushless DC (BLDC) electronically commutated motors (ECM) factory programmed and run tested in assembled units. Motors to soft ramp between speeds. Motors to be operated at three speeds. All motors shall have integral overload protection with a maximum ambient operating temperature of 104°F and use permanently sealed ball bearings. Motors shall operate at plus or minus 10% of rated voltage on all speed settings.

E. Water Coils:

1. Main coils shall be two, three, four or six row, dual-temp application.
2. Coils shall use aluminum fins mechanically bonded to seamless copper tubes, factory tested with 450 psig air under water.
3. Maximum operating conditions shall be 300 psig at 200F.
4. Sweat type connections shall be standard.
5. Include sloped drain pan, stainless steel, fully drainable, main and auxiliary connections of 3/4" PVC or threaded pipe.
6. All coils shall be provided with a manual air vent.

F. Accessories shall include 24VAC control transformer, and control enclosure. Factory mount and wire the DDC controller furnished as part of the work of ATC, coordinate with Section 230900.

G. Manufacturers: Carrier, International Environmental Corp., Daikin McQuay, Temtrol, Trane, York/JCI.

1. Any listed equivalent manufacturer and the Mechanical Contractor shall be completely responsible to comply with all requirements on the contract documents. This shall include, but not be limited to, space requirements, code clearances, the type, horsepower, capacities, number and size of services required from other trades.

2.2 AIR HANDLING UNITS (MODULAR, SECTIONAL TYPE)

A. The air handling units for central station air conditioning shall be sectional component type. Components shall include fan section, hot water heating coil section, access section(s) chilled water cooling coil section, DX cooling coil section, electric heater (humidity control), drain pan, double wall construction, filter/mixing box and air filters.

1. All segments shall be double wall construction and shall be constructed of G90 mill galvanized sheet steel, formed and reinforced to provide a rigid assembly.
2. The exterior casing shall be constructed of minimum 18-gauge galvanized steel.
3. The interior lining shall be a perforated lining of a minimum of 20 gauge. Units with double wall construction must have a full 2" (non-compressed) insulation throughout the entire unit.
4. All panels shall be insulated with 2" – 1.5# fiberglass insulation. The insulation shall meet the flame and smoke generation requirements of NFPA-90A.
5. All panels shall be completely gasketed prior to shipment with a minimum of 1/4" thick and 3/4" wide closed cell neoprene.
6. All access panels shall be completely removable for unit access and removal of components. All access panels must be removable without the use of electricity or compressed air. Panels will be removable with a hex wrench, or built-in latching handle.
7. Double wall access doors shall be provided in the fan and filter segments on the motor side of the unit. Access doors must also be provided in all segments where the removal of sheet metal screws is required for unit access.

Doors shall be of the same thickness and construction as the wall panels. A bulb-type gasket shall be provided around the entire door perimeter. Industrial style hinges shall permit a complete 180-degree door swing. A door stop will be provided on all positive pressure doors.

8. The exterior of the unit shall be completely cleaned prior to application of finished coats. A prime coat of epoxy chromate shall be applied to a minimum thickness 1.5 mils.

B. Mixing Section

1. A mixing section shall be provided to support the damper assembly for outdoor, return, and/or exhaust air.
2. Dampers shall modulate the volume of outdoor and return air. The dampers shall be of double skin airfoil design with metal, compressible jamb seals and flexible blade-edge seals on all blades. The blades shall rotate on stainless-steel sleeve bearings. The dampers shall be rated for a maximum leakage rate of 3 cfm/ft² at 1" w.g. complying with ASHRAE 90.1 maximum damper leakage. All leakage testing and pressure ratings shall be based on AMCA Standard 500-D. Actuators shall be provided by ATC.
3. Mixing sections shall be provided with a filter rack. 2-inch pleated media filters made with 100% synthetic fibers shall be provided. The filters shall have a MERV 8 rating when tested in accordance with the ANSI/ASHRAE Standard 52.2.

C. Coil Section with Factory Installed Coil

1. The coil section shall be provided complete with coil and coil holding frame. The coils shall be installed such that headers and return bends are enclosed by unit casings. If two or more cooling coils are stacked in the unit, an intermediate drain pan shall be installed between each coil and be of the same material as the primary drain pan.
2. The coil section complete with a double-wall, shall include a removable door downstream of the coil for inspection, cleaning, and maintenance. Interior and exterior door panels shall be of the same construction as the interior and exterior wall panels, respectively. All doors shall be provided with a thermal break construction of door panel and door frame.
3. Refrigerant Cooling Coils: The coils shall have aluminum fins and seamless copper tubes. The fins shall have collars drawn, belled, and firmly bonded to tubes by mechanical expansion of the tubes. Suction and liquid line connections shall extend to the unit exterior. The coil casing may be galvanized or stainless steel.

The coils shall be proof-tested to 715 psig and leak-tested to 650 psig air pressure under water or equivalent gas leak test. After testing, the inside of the coils shall be dried, all connections shall be sealed, and the coil shall be shipped with a charge of dry air or nitrogen.

Suction headers and liquid connections shall be constructed of copper tubing with connections penetrating unit casings to permit sweat connections to refrigerant lines. The coils shall have equalizing vertical distributors sized according to the capacities of the coils.

4. R454B Leak Detection Sensor: A factory-installed A2L class gas sensor designed for R454B refrigerant detection will be installed in the DX coil sections selected with R454B refrigerant. It utilizes thermal conductivity technology for quick and accurate leak detection and features automated self-calibration, self-diagnostics, immunity to poisoning and a 15-year life. The sensor comes set with a 15% LFL alarm threshold with +/-2.5% accuracy at 68°F (20°C) and +/-5% accuracy across the rest of the operating range of -40°F - 175°F (-40°C - 80°C).
5. Water Coils: The coils shall have aluminum fins and seamless copper tubes. Copper fins may be applied to coils with 5/8" tubes. Fins shall have collars drawn, belled, and firmly bonded to tubes by mechanical expansion of the tubes. The coil casing may be galvanized or stainless steel. The coils shall be proof-tested to 300 psig and leak-tested under water to 200 psig. Coil connections are constructed of cast iron with female connections, steel block with female connections or steel pipe with male connections.
 - a. Tubes are 1/2" OD 0.016" thick copper.
 - b. Refrigerant coil tubes are 1/2" OD, 0.016" thick, internally enhanced copper.

D. Electric Heat

1. A UL recognized electric heater shall be factory-installed in the air handler. The electric heat is an open-wire resistance heater and installed in the supply fan duct position. Safeties shall include three-pole, disconnection-type contactors, automatic-reset functional limits, automatic-reset high-temperature limits, and manual-reset high-temperature limits.
2. The electric heater shall be factory-wired to accommodate SSR-Full Modulating control. The SSR control can receive a 0-10 VDC signal from a building automation system providing full modulating control of the heater.
3. The electric heater will come with factory installed airflow switch, line fusing, and disconnect switch (when heater is below 100 amps and no unit casing).

E. Motor Frame

1. The motor shall be mounted integral to the isolated fan assembly and furnished by the unit manufacturer. The motor is mounted inside the unit casing on an adjustable base to permit adjustment of drive belt tension (not applicable for direct drive plenum fans). The motor shall meet or exceed all NEMA Standards Publication MG 1 requirements and comply with NEMA Premium efficiency levels when applicable except for fractional horsepower motors which are not covered by the NEMA classification. The motor shall be T-frame, squirrel case with size, type, and electrical characteristics as shown on the equipment schedule. Refer to the product data section for selected fan motors within each unit.

F. FC Fan Section

1. The fan type shall be provided as required for stable operation and optimum energy efficiency. The fan shall be a double-width, double-inlet, multiblade-type, forward-curved (FC) fan. The fan shall be equipped with self-aligning, anti-friction bearings with an L-50 life of 200,000 hours as calculated per ANSI/AFBMA Standard 9. For any bearing requiring relubrication, the grease line shall be extended to the fan support bracket on the drive side. The fan shall be statically and dynamically balanced at the factory as complete fan assembly (fan wheel, motor, drive, and belts). The fan shaft shall not exceed 75 percent of its first critical speed at any cataloged speed. Fan wheels shall be keyed to the fan shaft to prevent slipping. The fan shafts shall be solid steel. The fan section shall be provided with an access door on the drive side of the fan.

G. The air conditioning units shall be manufactured by: Daikin McQuay, Carrier Corporation, Trane Company, York/Johnson Controls.

1. Any listed equivalent manufacturer and the Mechanical Contractor shall be completely responsible to comply with all requirements on the contract documents. This shall include, but not be limited to, space requirements, code clearances, the type, horsepower, capacities, number and size of services required from other trades.

2.3 HEATING AND VENTILATING UNITS

- A. Units are completely factory assembled, piped, wired and test fired. All units contain duct furnaces that are ETL certified and conform with the latest ANSI Standards for safe and efficient performance. Units are mounted on metal rails suitable for slab or curb mounting. Units are available for operation on natural gas. The firing rate of each furnace will not exceed 400 MBh and contains its own heat exchanger, flue collector, venting, burners, safety, and ignition controls. All units are ETL certified for electrical safety in compliance with UL 1995 and CSA C22.2 No. 236 safety standard for heating, ventilating, and cooling equipment. Standard control relays socket mounted with terminal block connections.
- B. All control wiring terminates at terminal strips (single-point connection) and include an identifying marker corresponding to the wiring diagram. Casings are die formed, 18-gauge galvanized steel and finished in air dry enamel. Service and access panels are provided through easily removable side

access panels with captive fasteners. Fan sections are insulated with fire resistant, odorless, matte faced 1" glass fiber material. Outside air hoods ship with a wire mesh inlet screen. Standard heat exchanger construction consists of 20-gauge aluminized steel tubes and 18-gauge aluminized steel headers. Standard drip pan construction is corrosion resistant aluminized steel.

- C. Standard flue collector construction is corrosion resistant aluminized steel. Burners are die-formed, corrosion resistant aluminized steel, with stamped porting and stainless-steel port protectors.
- D. Filter rack is constructed of galvanized steel with access through the side service panel. Provide MERV8 filters plus one (1) spare set for Owner's stock. Electrical cabinet is isolated from the air stream with a non-removable access panel interior to the outer service panel. Motor and control wiring is harnessed with terminal block connections. Standard units are provided with 24-volt combination single stage automatic gas valves, including main operating valve and pilot safety shutoff, pressure regulator, manual main and pilot shutoff valve, and adjustable pilot valve. Gas valves are suitable for NEC Class 2 use for a maximum inlet gas pressure of 0.5 psi (14" W.C.) on natural gas. All rooftop units are provided with a low-voltage circuit breaker rated for 150% of the units normal 24-volt operating load.
- E. Each duct furnace is provided with a 24-volt high temperature limit switch, a (redundant) combination gas valve and a fan time delay relay.
- F. Centrifugal fan is belt driven, forward curved with double inlet, statically and dynamically balanced. The blower wheel is fixed on a keyed shaft, supported with rubber grommet on bearing only and ball bearing secured. An access interlock switch is installed in the blower compartment and will disengage the blower upon removing the service panel.
- G. Power vent units are provided with a vent fan. Outside air for combustion and products of combustion have individual air inlet and discharge grilles located in the upper section of the furnace service panel. An air proving switch is installed and disengages gas flow if for any reason the drafter has failed to operate.
- H. Provides modulated heat output. Ignition is at full fire (100% input), and modulates the gas input from 100% to 40% rated input. The modulating gas valve shall operate in response to a 4-20 mA or a 0-10 VDC input from an external DDC control.
- I. Heat exchanger tubes and headers shall be 20-gauge, type 409 stainless-steel. Burners and flue collector shall be 409 stainless-steel.
- J. Dampers are of the opposed blade type, constructed of galvanized steel with neoprene nylon bushings, blades to be mechanically interlocked. Modulating motor interlocked with outside and return air dampers is provided. The motor modulates the position of the outside and return air dampers in response to a 4-10 mA or 0-10 VDC signal supplied by an external DDC controller. Spring return feature drives the outside air damper full closed and the return air damper full open when the unit is shut down. Actuator shall be controlled by BAS.
- K. 409 stainless-steel furnace drip pan.
- L. Unit is supplied with the return air opening under the outside air opening location.
- M. The heating and ventilating units shall be manufactured by Trane Co., York/Johnson Controls, American Air Filter, Carrier.
 - 1. Any listed equivalent manufacturer and the Mechanical Contractor shall be completely responsible to comply with all requirements on the contract documents. This shall include, but not be limited to, space requirements, code clearances, the type, horsepower, capacities, number and size of services required from other trades.

2.4 PACKAGED AIR-TO-AIR ENERGY RECOVERY UNIT

- A. Factory fabricated and assembled unit consisting of constant volume fans, motors, and drive

assemblies, coils, plenum casing, filters, energy recovery wheel (with motor and drive), motor-operated outside air and exhaust air dampers, access doors.

B. Casing:

1. Unit casing shall be constructed of zinc coated, heavy gauge, galvanized steel. Exterior surfaces shall be cleaned, phosphatized, and finished with a weather-resistant baked enamel finish. Unit's surfaces shall be tested 672 hours in a salt spray test in compliance with ASTM B117. Unit shall have 2-inch thick Antimicrobial two-component rigid polyurethane foam insulation, metal encapsulated with no exposed edges. Initial R value of 6.7 per inch of thickness. The unit's base pan shall have no penetrations within perimeter of the curb other than the raised downflow supply/return openings.
2. The top cover shall be one-piece construction or, where seams exist, it shall be double-hemmed and gasket-sealed. The ribbed top adds extra strength and enhances water removal from unit top.

C. Indoor Coil Type: DX

1. Internally finned, inch copper tubes mechanically bonded to a configured aluminum plate fin shall be standard. Coils shall be leak tested at the factory to ensure the pressure integrity. The evaporator coil shall be leak tested to 500 psig and pressure tested to 500 psig. A stainless-steel double-sloped condensate drain pan with provision for through the unit wall condensate drain is standard. Evaporator coil will have six interlaced rows for superior sensible and latent cooling.

D. Reheat: Fin & Tube Modulating HGRH

1. This shall consist of a modulating hot-gas reheat coil located on the leaving air side of the evaporator coil pre-piped and circuited with a low-pressure switch.

E. Compressor

1. The units shall have direct-drive, hermetic, digital scroll type compressors with centrifugal type oil pumps. Motor shall be suction gas-cooled and shall have a voltage utilization range of plus or minus 10 percent of unit nameplate voltage. Internal overloads shall be provided with the scroll compressors. Crankcase heaters shall be included. Compressor shall be able to fully modulate from 20% - 100%.

F. Outdoor Coil Type

1. Internally finned, copper tubes mechanically bonded to a configured aluminum plate fin shall be standard. Coils shall be leak tested at the factory to ensure the pressure integrity. The condenser coil shall be leak tested to 500 psig and pressure tested to 500 psig. The condenser coil shall have a fin design with slight gaps for ease of cleaning.

Outdoor fans: Shall be direct drive vertical discharge design with low-noise corrosion resistant glass reinforced polypropylene props, powder coated wire discharge guards and electro-plated motor mounting brackets. Fans shall be statically and dynamically balanced.

G. Capacity Control: R-454B – Low GWP Refrigerant & No RCC Valve

1. All units shall be fully charged with R-454B. Units shall be ETL listed and labeled, classified in accordance to UL 60335-2-40/CSA C22.2 No. 60335-2-40 for Central Cooling Air Conditioners.

H. Heat Capacity

1. Primary heat is supplied using indirect fired gas heating. The heating section shall have a progressive tubular heat exchanger design using Stainless-Steel burners and type 439 stainless-steel tubes. The heater shall use direct spark ignition (DS) system. Unit shall be suitable for use with natural gas. Minimum incoming gas pressure for 7" W.C. and maximum pressure of 14" W.C. required. Factory provided 25-year heat exchanger warranty.

I. Supply Fan Motor Type: Direct Drive w/ VFD

1. Supply fan motor shall be direct drive type with factory installed variable frequency drive (VFD). All motors shall be thermally protected. All fans shall be mounted on rubber vibration isolators.
- J. Exhaust Fan Motor Type: Direct Drive w/ VFD
 1. Exhaust fan motor shall be direct drive type with factory installed variable frequency drive (VFD). All motors shall be thermally protected. All fans shall be mounted on rubber vibration isolators.
- K. Filter
 1. Aluminum mesh filters shall be installed on the intake of the unit. In addition, one row of 2-inch MERV-8 rated prefilters (30 percent) and 2-inch MERV-13 final filter (80 percent) installed prior to the evaporator coil.
 2. Provide one (1) spare set of filters for each unit for Owner's attic stock.
- L. Energy Recovery: ERV-Composite Construction with Frost Control and Bypass
 1. Energy recovery wheel performance shall be AHRI 1060 certified and bear the AHRI certified label. The rotating wheel heat exchanger is composed of a rotating cylinder in an insulated cassette frame complete with removable energy transfer media, seals, drive motor and drive belt. Energy transfer media shall be constructed of a durable synthetic lightweight polymer. The total energy recovery wheel is coated with a desiccant that is permanently bonded to the energy transfer media without the use of binders or adhesives. Bypass damper shall be controlled by ATC.
- M. Hailguards
 1. Hail guards shall be installed on the outside of the condenser coil. The guards shall consist of perforated metal, of the same gauge and color as the unit itself. Guards shall be removable to accommodate coil cleaning.
- N. Damper
 1. The unit shall be provided with a factory installed 100% outdoor air hood and exhaust hood with damper, actuator end switches. Damper shall be controlled by ATC.
- O. BAS controller: Provided by ATC.
- P. Power/Electrical Section
 1. Unit shall be equipped with a single point electrical connection with motor starters, relays, voltage transformer and terminal block for controls interface, factory mounted disconnect switch.
 2. Unit shall include a laminated, color coded electrical wiring diagram attached to the door of the unit. Damper actuators shall be wired to the units low voltage terminal block. All components are UL listed, approved, or classified.
 3. BAS Controller: DDC controller shall be provided as part of the work of ATC, field-mounted and wired. Coordinate with Section 230900.
- Q. Roof Curb: Prefabricated galvanized steel mounting curb shall be provided for field assembly on the roof decking prior to unit placement. The roof curb shall be a perimeter type with complete perimeter support of the air handler unit. The curb shall be a minimum of 12" high. Gasketing shall be provided for field mounting between the unit base and roof curb. Curb shall include a 2" x 4" wood nailer.
- R. Manufacturers: Basis of design, Trane. Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work are limited to one of the following:
Addison
Modine

Innovent

York/JCI

Valent

1. Any listed equivalent manufacturer and the Mechanical Contractor shall be completely responsible to comply with all requirements on the contract documents. This shall include, but not be limited to, space requirements, code clearances, the type, horsepower, capacities, number and size of services required from other trades.

2.5 PACKAGED ROOFTOP HVAC UNIT w/ ENERGY RECOVERY

- A. Factory fabricated and assembled unit consisting of constant volume fans, motors, and drive assemblies, coils, plenum casing, filters, energy recovery wheel (with motor and drive), motor-operated outside air and exhaust air dampers, access doors.
- B. Casing:
 1. Unit casing shall be constructed of zinc coated, heavy gauge, galvanized steel. Exterior surfaces shall be cleaned, phosphatized, and finished with a weather-resistant baked enamel finish. Unit's surfaces shall tested 672 hours in a salt spray test in compliance with ASTM B117. Unit shall have 2-inch thick Antimicrobial two-component rigid polyurethane foam insulation, metal encapsulated with no exposed edges. Initial R value of 6.7 per inch of thickness. The unit's base pan shall have no penetrations within perimeter of the curb other than the raised downflow supply/return openings.
 2. The top cover shall be one-piece construction or, where seams exist, it shall be double-hemmed and gasket-sealed. The ribbed top adds extra strength and enhances water removal from unit top.
- C. Indoor Coil Type: DX
 1. Internally finned, inch copper tubes mechanically bonded to a configured aluminum plate fin shall be standard. Coils shall be leak tested at the factory to ensure the pressure integrity. The evaporator coil shall be leak tested to 500 psig and pressure tested to 500 psig. A stainless-steel double-sloped condensate drain pan with provision for through the unit wall condensate drain is standard. Evaporator coil will have six interlaced rows for superior sensible and latent cooling.
- D. Reheat: Fin & Tube Modulating HGRH
 1. This shall consist of a modulating hot-gas reheat coil located on the leaving air side of the evaporator coil pre-piped and circuited with a low-pressure switch.
- E. Compressor
 1. The units shall have direct-drive, hermetic, digital scroll type compressors with centrifugal type oil pumps. Motor shall be suction gas-cooled and shall have a voltage utilization range of plus or minus 10 percent of unit nameplate voltage. Internal overloads shall be provided with the scroll compressors. Crankcase heaters shall be included. Compressor shall be able to fully modulate from 20% - 100%.
- F. Outdoor Coil Type
 1. Internally finned, copper tubes mechanically bonded to a configured aluminum plate fin shall be standard. Coils shall be leak tested at the factory to ensure the pressure integrity. The condenser coil shall be leak tested to 500 psig and pressure tested to 500 psig. The condenser coil shall have a fin design with slight gaps for ease of cleaning.

Outdoor fans: Shall be direct drive vertical discharge design with low-noise corrosion resistant glass reinforced polypropylene props, powder coated wire discharge guards and electro-plated motor mounting brackets. Fans shall be statically and dynamically balanced.

- G. Capacity Control: R-454B – Low GWP Refrigerant & No RCC Valve
 - 1. All units shall be fully charged with R-454B. Units shall be ETL listed and labeled, classified in accordance to UL 60335-2-40/CSA C22.2 No. 60335-2-40 for Central Cooling Air Conditioners.
- H. Heat Capacity
 - 1. Primary heat is supplied using indirect fired gas heating. The heating section shall have a progressive tubular heat exchanger design using Stainless-Steel burners and type 439 stainless-steel tubes. The heater shall use direct spark ignition (DS) system. Unit shall be suitable for use with natural gas. Minimum incoming gas pressure for 7" W.C. and maximum pressure of 14" W.C. required. Factory provided 25-year heat exchanger warranty.
- I. Supply Fan Motor Type: Direct Drive w/ VFD
 - 1. Supply fan motor shall be direct drive type with factory installed variable frequency drive (VFD). All motors shall be thermally protected. All fans shall be mounted on rubber vibration isolators.
- J. Exhaust Fan Motor Type: Direct Drive w/ VFD
 - 1. Exhaust fan motor shall be direct drive type with factory installed variable frequency drive (VFD). All motors shall be thermally protected. All fans shall be mounted on rubber vibration isolators.
- K. Filter
 - 1. Aluminum mesh filters shall be installed on the intake of the unit. In addition, one row of 2-inch MERV-8 rated prefilters (30 percent) and 2-inch MERV-13 final filter (80 percent) installed prior to the evaporator coil.
 - 2. Provide one (1) spare set of filters for each unit for Owner's attic stock.
- L. Energy Recovery: ERV-Composite Construction with Frost Control and Bypass
 - 1. Energy recovery wheel performance shall be AHRI 1060 certified and bear the AHRI certified label. The rotating wheel heat exchanger is composed of a rotating cylinder in an insulated cassette frame complete with removable energy transfer media, seals, drive motor and drive belt. Energy transfer media shall be constructed of a durable synthetic lightweight polymer. The total energy recovery wheel is coated with a desiccant that is permanently bonded to the energy transfer media without the use of binders or adhesives. Bypass damper shall be controlled by ATC.
- M. Hailguards
 - 1. Hail guards shall be installed on the outside of the condenser coil. The guards shall consist of perforated metal, of the same gauge and color as the unit itself. Guards shall be removable to accommodate coil cleaning.
- N. Damper
 - 1. The unit shall be provided with a factory installed 100% outdoor air hood and exhaust hood with damper, actuator end switches. Damper shall be controlled by ATC.
- O. BAS controller: Provided by ATC.
- P. Power/Electrical Section
 - 1. Unit shall be equipped with a single point electrical connection with motor starters, relays, voltage transformer and terminal block for controls interface, factory mounted disconnect switch.
 - 2. Unit shall include a laminated, color coded electrical wiring diagram attached to the door of the unit. Damper actuators shall be wired to the units low voltage terminal block. All components are UL listed, approved, or classified.

3. BAS Controller: DDC controller shall be provided as part of the work of ATC, field-mounted and wired. Coordinate with Section 230900.
- Q. Roof Curb: Prefabricated galvanized steel mounting curb shall be provided for field assembly on the roof decking prior to unit placement. The roof curb shall be a perimeter type with complete perimeter support of the air handler unit. The curb shall be a minimum of 12" high. Gasketing shall be provided for field mounting between the unit base and roof curb. Curb shall include a 2" x 4" wood nailer.
- R. Manufacturers: Basis of design, Trane. Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work are limited to one of the following:
- Addison
Modine
Innovent
York/JCI
Valent
1. Any listed equivalent manufacturer and the Mechanical Contractor shall be completely responsible to comply with all requirements on the contract documents. This shall include, but not be limited to, space requirements, code clearances, the type, horsepower, capacities, number and size of services required from other trades.
- 2.6 SINGLE PACKAGED, GAS-FIRED ROOFTOP AIR CONDITIONING UNIT
- A. General
1. The packaged rooftop unit's cooling capabilities, heating capabilities, and efficiencies are certified to AHRI Standard 210/240. It is listed to UL standard 60335-2-40. It is factory-assembled, internally wired, fully charged, and 100 percent run-tested to verify cooling operation, fan and blower rotation, and control sequence before leaving the factory. The unit features colored and numbered wiring internally for simplified identification and is cULus listed and classified in accordance with Central Cooling Air Conditioners. Additionally, the unit shall be furnished with a leak detection system from the factory, consisting of one or more refrigerant detection sensors. When the system detects a leak, the unit controller shall initiate mitigation actions.
- B. Casing
1. The unit casing is constructed from zinc-coated, heavy-gauge, galvanized steel and features weather-resistant pre-painted metal with a galvanized substrate. It meets the ASTM B117 standard for a 672-hour salt spray test. The unit includes removable single-side maintenance access panels, which are equipped with lifting handles. These handles can be removed and reinstalled by removing fasteners, while still providing a water and airtight seal. The exposed vertical panels and top covers in the indoor air section are insulated with a cleanable, foil-faced, fire-retardant, permanent, odorless glass fiber material. The base pan has no penetrations within the perimeter of the curb, except for the raised 1-inch high downflow supply/return openings. The base of the unit is insulated with 1/8", foil-faced, closed-cell insulation.
- C. Compressors
1. All units are equipped with direct-drive, hermetic, scroll-type compressors featuring centrifugal-type oil pumps. The compressors have suction gas-cooled motors with a voltage utilization range of plus or minus 10% of the unit nameplate voltage. Internal overloads are standard with scroll compressors, and crankcase heaters are included on all compressors. Each unit includes a liquid line refrigerant drier. The units feature dual compressors and two stages of cooling.

- D. Indoor Fan
 - 1. The indoor fan features a direct-drive plenum fan design with a backward-curved fan wheel and an external rotor direct drive variable speed indoor motor. The motors are electronically protected and are high-efficiency variable speed direct drive motors.
- E. Evaporator and Condenser Coils
 - 1. The evaporator and condenser coils are flat, streamlined tubes with small ports and a metallurgical tube-to-fin bond. The compact all-aluminum microchannel coils reduce the unit's weight. The aluminum brazed structure provides better fin protection; the coils are leak-tested at the factory to verify their pressure integrity.
- F. Phase Monitor
 - 1. Phase monitor protects 3-phase equipment from phase loss, phase reversal and phase imbalance. Any fault condition shall produce a failure indicators LED and send the unit into an auto stop condition.
- G. Gas Heating Section
 - 1. The cabinet features a tubular heat exchanger available in low, medium, and high heat capacities. Corrosion-resistant aluminized steel tubes and burners are standard on all models. An induced draft combustion blower is used to pull the combustion products through the firing tubes. The heater utilizes a direct spark ignition (DSI) system and a flame sensor as a safety device to validate the flame.
- H. Modulating Hot Gas Reheat (HGRH)
 - 1. The modulating hot gas reheat (HGRH) humidity control system allows for full independent control of latent capacity via a staged or modulating refrigeration system and independent control of discharge air temperature via a modulating hot gas reheat valve. The system includes both relative humidity and dew point control.
- I. Standard Filters
 - 1. 2-inch filters. Provide one spare set of filters for each unit for Owner's stock.
- J. Standard Drain Pan
 - 1. The standard drain pan features an easy-to-clean, composite, removable, dual-sloped drain pan.
- K. Coil Guards
 - 1. Coil Guards are factory installed to provide condenser coil protection.
- L. Standard Economizer (Comparative Enthalpy Control)
 - 1. The standard economizer features fully modulating 0 to 100% motor and dampers, with a minimum position setting, preset linkage, wiring harness with plug, spring return actuator, and comparative enthalpy control.
- M. Exhaust Air Relief Dampers
 - 1. Economizer shall be equipped with barometric dampers that will open the exhaust return air as more outdoor air is supplied to the conditioned space during economizer operation. This relief shall prevent the conditioned space from over-pressurizing during economizer operation.
 - 2. Exhaust air opening shall be covered with a birdscreen and a rain hood that matches the exterior of the unit.
- N. Roof Curb
 - 1. Roof curb shall be supplied by the unit manufacturer to provide a watertight seal between the roof and the unit.

2. Roof curb shall be approved by the National Roofing Contractor's Association.
 3. Roof curb shall be full perimeter with all utility and duct connections within the perimeter of the curb eliminating the need to other roof penetrations.
 - O. Basic Safety/Operating Controls – Unit manufacturer shall supply the following safety/operating control features:
 1. A thermostat to deenergize the compressors when the suction line temperature drops below 22°F.
 2. A five-minute timer to prevent the compressor from short cycling.
 3. A lock out circuit to prevent the compressors from cycling on one of their safety controls.
 4. A cutout to protect the compressors during abnormally low voltage conditions.
 - P. Unit shall be completely factory-wired, piped, charged, and tested by the manufacturer before shipment. BAS Controller: DDC Controller shall be provided as part of the work of ATC, field-mounted and wired. Coordinate with Section 23 09 00.
 - Q. Manufacturer: Trane, York/Johnson Controls, Carrier
 - R. Manufacturer shall furnish start-up.
 1. Any listed equivalent manufacturer and the Mechanical Contractor shall be completely responsible to comply with all requirements on the contract documents. This shall include, but not be limited to, space requirements, code clearances, the type, horsepower, capacities, number and size of services required from other trades.
- 2.7 PACKAGED GAS-FIRED ROOFTOP UNIT (KITCHEN VENTILATION)
- A. Unit Construction:
 1. All sheet metal parts shall be constructed of 18-gauge commercial grade galvanized steel. All external surfaces shall be finished with manufacturer's standard color enamel coating system.
 2. Removable side panel shall provide easy access for maintenance, service and adjustment of components within the supply fan section and filter/damper section.
 3. Unit shall be single wall construction with foil faced insulation minimum 1" thick fiberglass pinned to housing and designed for NPFA 90A requirements.
 4. Unit shall have lifting lugs on each of the corners, factory assembled, except where larger units require two-piece shipment.
 5. Modular sections shall include insulated downturn supply plenum, gas-fired heater section, supply fan, filter/damper section and air intake section.
 6. All modules shall be of weatherproof design, joined with Ductmate connectors.
 - B. Outdoor Air/Filter/Damper Section:
 1. Outdoor air damper shall be provided with a factory mounted and wired damper actuator and end switch. Actuator shall be spring return so that the outdoor air intake damper will close when power to the unit is interrupted. Damper actuator shall be mounted inside housing. Damper to be controlled by ATC.
 2. Maximum leakage rate for the outdoor air intake dampers shall not exceed 2% when fully closed and operating against a pressure differential of 0.5" W.C.
 3. The outdoor intake opening shall be covered with a removable inlet birdscreen and a rain hood that matches the exterior of the unit.
 4. Filters shall be 2" thick replaceable type MERV 8 and internal metal frame work.
 - C. A 1,750-rpm single supply air blower motor shall have a 1.15 service factor, solid base, Class B insulation and ball bearings with permanent lubrication. All belts and pulleys shall be treated with

permanent lubrication. All belts and pulleys shall be rated at least 65% above the nominal drive horsepower. The fan shaft ball bearings shall have an average life rating of 100,000 hours of operation. Fan shaft shall be machined from SAE 1020 cold rolled steel. Fans shall be FC Type, DWDI design. Fan and drive assembly shall be mounted on rubber isolators with adjustable motor base.

D. Roof Curb:

1. Roof curb shall be supplied by the unit manufacturer to provide a watertight seal between the roof and the unit.
2. Roof curb shall be approved by the National Roofing Contractor's Association.
3. Roof curb shall be full perimeter with all duct connections within the perimeter of the curb eliminating the need for other roof penetrations.

E. Gas Heating Section:

1. Manufacturer shall furnish a natural gas furnace AGA labeled and constructed of 20-gauge Type 409 stainless steel tubes. Provide Type 409 stainless steel flue collector and side vent with cap.
2. Furnace shall be as manufactured by Sterling and include the following controls and safety devices:
 - a. Intermittent spark ignition with two stage gas valve with pilot gas valve pressure regulator.
 - b. Centrifugal blower to maintain positive flue pressure with air pressure safety switch.
 - c. Electronic ignition with flame sensor and lockout safety valve.
 - d. High temperature limit thermostat with automatic reset.
 - e. 24-volt control voltage.

F. Unit shall be completely factory wired, piped and tested by the manufacturer before shipment.

G. Unit-mounted motor control center shall be factory installed, wired and include the following components:

1. Single point power connections within NEMA 3R enclosures for fused disconnect switch and motor controls.
2. Magnetic contactors with overload protection in all legs.
3. Reset for supply fan, with interlocking contactor, additional contactor for motor-operated outside air damper.
4. Fused transformer to provide secondary 24 VAC control voltage for heater section control and control panel on face of kitchen hood. Electronic modulating discharge temperature control with internal setpoint selector.
5. All components U.L. listed or classified and wired per N.E.C.

H. Exhaust fan section shall be field mounted and wired. Fan shall be as scheduled on drawings and as specified in Section 230605.

I. Accessories:

1. Remote discharge air temperature setpoint controller for field mounting. Control interface with unit-packaged control center shall be part of the work of Division 23- Mechanical.
2. Provide 24VAC control voltage relays for interface between unit packaged control center and heat detectors furnished with the kitchen type I ventilator package for automatic operation of the makeup air unit and its associated ventilator exhaust fan.

J. Manufacturer: Kees, Inc., Greenheck, Captive Aire, Weather-Rite.

1. Any listed equivalent manufacturer and the Mechanical Contractor shall be completely responsible to comply with all requirements on the contract documents. This shall include, but not be limited to, space requirements, code clearances, the type, horsepower, capacities, number and size of services required from other trades.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which equipment is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to installer.
- B. Install in accordance with manufacturer's recommendations. Unit and all component sections shall be properly supported and vibration isolated.

3.2 INSTALLATION

- A. Verify that coils, filters, motors, drives and other components are matched with the proper unit.
- B. Assemble unit components following manufacturer's instructions for handling, testing and operation. Repair damaged galvanized areas, and paint in accordance with manufacturer's written recommendations.
- C. Vacuum clean interior of units prior to operation.
- D. Repair air leaks from or into casing that can be heard or felt during normal operation.
- E. Install rooftop units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.
- F. Support: Install and secure roof curb to roof structure, in accordance with National Roofing Contractors Association (NRCA) installation recommendations and shop drawings. Install and secure rooftop units on curbs and coordinate roof penetrations and flashing.
- G. Perform field mechanical balancing in accordance with Section 230950: TESTING AND BALANCING OF MECHANICAL SYSTEMS.
- H. The Mechanical Contractor shall own as part of his work, the following:
Provide one (1) additional drive set, if necessary, to obtain final design balancing requirements. The Mechanical Contractor shall coordinate with Balancing Firm and equipment manufacturer for drive selection, including belts and pulleys.
- I. Provide certified factory start-up and written report on all units.

3.3 AUTOMATIC TEMPERATURE CONTROLS

- A. Coordination of control work with the BAS shall include, but not be limited to, items as described in Section 230900: ATC.

END OF SECTION

SECTION 23 08 61
AIR PURIFICATION SYSTEM

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the contract, including the conditions of the contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the work specified in this section.
- B. Refer to Section 230200 for HVAC General Provisions.
- C. Refer to Section 230210 for HVAC Basic Materials & Methods.

1.2 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 as shown on the plans, details and equipment schedules.
- B. This Section includes work necessary and/or required and materials and equipment for construction of a complete system.

1.3 REFERENCED STANDARDS

- A. Refer to Section 230200 for a general description of requirements applying to this section.
- B. 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 867-2007 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.

1.4 QUALITY ASSURANCE

- A. Refer to Section 230210 for a general description of requirements applying to this Section.
- 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. Submit shop drawings in accordance with Section 230200.
- B. 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).
 - 9. Job-specific, factory wiring diagrams and instructions for field installation of all components.

1.6 SUBSTITUTIONS

- A. The listed equivalent or substituted manufacturers along with the bidding related contractor shall be completely responsible to comply with all requirements on all contract documents. This shall

include, but not limited to, space requirements, code clearances, the type, horsepower, capacities, number and size of services required from other trades, including all required ancillary items provided by other trades. If the manufacturer or related bidding contractor does not comply with these requirements, this Contractor shall be responsible for any and all additional costs associated with the changes required by other trades.

1.7 WARRANTY

- A. Equipment shall be warranted by the manufacturer against defects in material and workmanship for a period of two years. Labor to replace equipment under warranty shall be provided by the owner or installing contractor.

PART 2 – PRODUCTS

2.1 AIR PURIFICATION SYSTEM

- A. GENERAL: 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. Each air handling unit, so designated on the drawings, details, equipment schedules and/or specifications shall contain a Plasma Generator with Bi-polar Ionization output as described herein.
- C. 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. 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 manufacturers 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. 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.

- 6. Capable of modular field assembly in 6-inch sections.
- D. 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.
- E. 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.
- F. 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" apart shall not be acceptable. The plasma electrode shall require no more than 1.0" 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-inch 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.
- G. Air Handler Mounted Units: Where so indicated on the plans and/or schedules. 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.
- H. Plasma Requirements: Plasma Generators with Bi-polar ionization output shall be capable of controlling gas phase contaminants and shall be provided.
1. 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.
 2. 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.

3. 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.
 4. Each plasma electrode shall be made from an all composite, UL 94V0 and UL 746C rated material for prevention of corrosion and electrical insulation.
 5. Ozone Generation: The operation of the electrodes or Bi-polar ionization units shall conform to UL 2998 as tested by UL proving no ozone output.
- I. 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 or 115 VAC, 1 phase, 60 Hz. Coordinate all electrical requirements with air purification manufacturer's submittals.
- J. 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. The ionization system shall be provided with a stand-alone, independent ion sensor designed for plenum 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. Manufacturers not providing a stand-alone ion sensor shall not be acceptable. System shall be tied into the fan circuit to only be energized when fan is operating.
 4. Mount and wire the Plasma device within the air handling unit specified or as shown on the drawings. The contractor shall follow all manufacturer IOM instructions during installation.
 5. Provide a pilot relay for each system. System shall be energized by ATC.
 6. System shall be tied into fan circuit and only operate when fan is running.
 7. A 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, as noted on the schedule.
- K. Manufacturers: Global Plasma Solutions, American Ion, Active Air Solutions, Plasma Aire Int, Bioclimatic.
1. Any listed equivalent manufacturer and the Mechanical Contractor shall be completely responsible to comply with all requirements on the contract documents. This shall include, but not be limited to, space requirements, code clearances, the type, horsepower, capacities, number and size of services required from other trades.

PART 3 – EXECUTION

3.1 GENERAL

- A. The Contractor shall be responsible for maintaining all air systems until the owner accepts the building.

3.2 ASSEMBLY: PLASMA GENERATOR

- A. All equipment shall be assembled and installed in a workmanlike manner to the satisfaction of the manufacturer's authorized representative.
- B. Any material damaged by handling, water or moisture shall be replaced, 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 START-UP & TRAINING

- A. A manufacturer's local authorized representative shall provide installation, start-up supervision, and training of owner's personnel in the proper operation and maintenance of all equipment.

END OF SECTION

SECTION 23 09 00**AUTOMATIC TEMPERATURE CONTROL****PART 1 – GENERAL****1.1 RELATED DOCUMENTS**

- A. Section 230200 and drawings are hereby made a part of this section as fully as if repeated herein.
- B. The Mechanical Contractor shall coordinate with the work of Division 26 and the Fire Alarm System vendor for locations and mounting of all duct smoke detectors and carbon monoxide detectors. All locations shall be determined based on approved shop drawings from the Fire Alarm System vendor and the Contractor for the work of Division 26, Electrical.

1.2 DESCRIPTION OF WORK

- A. Provide labor, material and supervision necessary to install a complete direct digital control system of temperature controls with a host PC and full color graphics to control all HVAC Systems, associated components and accessories as described herein.

1.3 SUBMITTALS

- A. Submit shop drawings and manufacturer's data sheets of all equipment.
- B. Submit manufacturer's certificates of conformance with applicable codes.
- C. Furnish point-to-point diagram of automatic temperature control system approval, including heating, ventilating and air conditioning equipment wiring diagrams where temperature control connections are required.
- D. Provide submittal data within thirty (30) days of contract award.
- E. Submittal shall consist of:
 - 1. System Architecture showing all digital actuated devices.
 - 2. Equipment lists of all proposed devices and equipment including data sheets of all products.
 - 3. Valve, damper and well and tap schedules showing size, configuration, capacity and location of all equipment.
 - 4. Data entry forms for initial parameters. Contractor shall provide English listing of all analog points with columnar blanks for high and low warning limits and high and low alarm limits, and a listing of all fan systems with columnar blanks for beginning and end of occupancy periods; and samples of proposed text for points and messages (for at least two systems of at least 15 points total) including sample 480-character alarm message. All text shall be approved prior to data entry.
 - 5. Wiring and piping interconnection diagrams including panel and device power and sources.
 - 6. Sketches of all graphics.

1.4 QUALITY ASSURANCE

- A. Ensure that all work and equipment is installed in accordance with manufacturer's warranty requirements.
- B. Provide adequate supervision of labor force to assure that all aspects of specifications are being fulfilled.
- C. The system shall be engineered, programmed and installed by personnel trained and regularly employed by the control's manufacturer.
- D. Supplier shall have technical support to promptly respond within 24 hours or less to service calls to the site with technical staff, spare parts inventory and test and diagnostic equipment.
- E. Codes and Approvals:

1. The complete system installation shall be in strict accordance with national and local electrical codes. All devices designed for or used in line voltage applications shall be UL listed.
 - a. All microprocessor-based devices shall be UL916 listed.
 - b. All electrical environmental control and monitoring devices shall be UL429 and/or UL873 listed.
 2. All electronic equipment shall conform to the requirements of FCC regulation Class B, Part 15, Section 15 governing radio frequency electromagnetic interference and be so labeled.
 3. The complete system shall conform to ANSI/ASHRAE Standard 135-2012, BACNET.
- F. All system components shall be designed and built to be fault tolerant.
1. Provide satisfactory operation without damage at 100% above and 85% below rated voltage and at +3 Hertz variation in line frequency.
 2. Provide static, transient, and short circuit protection on all inputs and outputs. Communication lines shall be protected against incorrect wiring, static transients and induced magnetic interference. Bus connected devices shall be A.C. coupled or equivalent so that any single device failure will not disrupt or halt bus communication.
- 1.5 ELECTRICAL WIRING
- A. All electrical wiring, components and accessories in connection with the Automatic Temperature Control System shall be furnished and installed by the control manufacturer.
1. Electrical Contractor shall provide all wiring to duct smoke detectors.
 2. Electrical Contractor shall provide all wiring to carbon monoxide detectors.
 3. Unless stated otherwise in the design documents, the ATC Contractor is responsible for providing control power to all valves, actuators, devices and components within the DDC System regardless of the selected voltage of those devices. This also includes all 120 volt power circuits required for devices, panels and control equipment.
 4. The ATC Contractor shall be responsible for providing the control interface between terminal unit condensate pumps and their respective units at the required voltage of these devices in order to shut down the terminal unit in the event of high water level in the condensate pump receiver.
- B. Control wiring shall include all wiring necessary to interface with new controls, such as electric relays and transducers, and shall also include electric and electronic devices such as freezestats, electronic sensors, relays, flow switches and controlled devices such as valve and damper operators, both electric/electronic actuated devices. Pilot devices such as ON/OFF switches and thermostats installed in series with line voltage circuits shall be considered to be control wiring.

1.6 AUTOMATIC TEMPERATURE CONTROL

- A. Provide a DDC System of automatic temperature control which shall be as manufactured by Alerton Technologies, Inc., or approved equal. The system shall be complete in all respects including labor, materials, equipment and services necessary.
- B. All electrical wiring in connection with the installation of the automatic temperature control system shall be furnished and installed under the direct supervision of the control manufacturer.

PART 2 – PRODUCTS

2.1 BMCS COMPUTER HARDWARE

- A. The host computer and accessories shall be provided by the Owner.

2.2 TEMPERATURE SENSORS

- A. Solid state room sensors shall be of the wire wound resistance type element. Sensors shall be equipped with visual readout and adjustment. Sensors shall be of the completely solid state type with

no moving contacts. Printed circuit board under thermostat cover shall contain a low mass resistance type setpoint dial and amplifier. Provide test points for measuring output voltage. Sensors shall be direct or reverse acting as required for the sequence of operation.

- B. Sensors shall provide the application for night setback override.
- C. Sensors shall be mounted at ADA height (48" above floor).

2.3 SMOKE DETECTORS

- A. Duct type ionization smoke detectors shall be furnished by the Electrical Contractor (supplied by JCI) and installed by the Mechanical Contractor in the supply and return air stream. The Electrical Contractor shall provide wiring from each detector to the Fire Alarm System panel.
- B. The Electrical Contractor shall provide an alarm output signal from the FAS panel to the BAS for unit shutdown.

2.4 ACTUATORS

- A. Electronic actuators shall be sized to operate their appropriate dampers and valves with sufficient reserve power to provide smooth modulating action or two-position action as specified.
- B. Provide integral, auxiliary switches for direct coupled actuators to indicate when a desired position is reached or to interface additional controls for a specific sequence.
- C. Align actuator with drive shaft, provide permanent mark to identify closed position of end device.

2.5 SENSOR TRANSMITTERS

- A. Duct and immersion sensors shall have minimum spans as required to meet the temperature requirements. Duct sensors shall have sensing elements of sufficient length and accuracy to measure average duct temperature in each location.
- B. Sensors shall be of corrosion resistant construction, tamperproof, suitable for mounting on a vibrating surface. Exposed capillaries shall be temperature compensated, and armored or installed in protective tubing.
- C. All sensing elements for water pipe mounting shall be of the rod and tube type with linear output and shall be furnished complete with separable protecting wells filled with heat conductive compound. Sensors shall be factory calibrated and tamperproof. If easily adjustable sensors are provided, they shall be located inside metal enclosures with cylinder lock and key to prevent unauthorized setting.
- D. Safety Devices: Provide the following:
 - 1. Low limit, electric type, with 20' long serpentine element, with manual reset, set for 37°F for "freeze" protection and 55°F for fan discharge application, unless otherwise noted.
 - 2. Air and water duty flow switches: Current **switch** type for fan and pump status.
 - 3. Carbon dioxide sensor/transducer suitable for wall or duct mounting.
 - a. Analog output of 4 to 20 milliamps corresponding to 0 to 2000 ppm CO₂.
 - b. ABS plastic housing, suitable for an operating environment of 0 to 125 F/ 0 to 100% RH, non-condensing.
 - c. Repeatability less than +/- 20 ppm.
 - d. Response time less than 60 seconds.
 - e. Power supply, 24 VAC.
 - f. Make: Vaisala Inc. model GMW 21 (wall)
GMD 20 (duct)

- g. Manufacturers: Air Test Technologies, Inc., Macurco, Rotronic Instrument Corp., Vaisala, Inc.
- 4. Make-up Water Monitoring System (Typical for chilled water & hot water heating system): (Manufacturer's Rep. 888-397-5353)
 - a. Monitor data as received by flow meter on cold water make-up system. When flow exceeds 10 gal./1 min (adj.), ATC system to close normally open solenoid valve, alarm system (provide call out), shutdown boilers, pumps, chillers, etc., associated with respective system.
 - b. Flow sensor, consisting of a removable flow sensor mounted in cast bronze housing, available in ½" to 1-1/2" pipe size. Sensor shall be rated for a flow range of 0.5 to 15 feet per second, 220°F max., 400 psig at 100°F max. pressure; Nylon impeller, Pennlon bearing, tungsten carbide shaft, PPS housing and EPDM seals. Manufacturer: Kele Model 250B, Data Industrial Series 250BR.
 - c. Programmable analog flow transmitter shall be a loop-powered device that converts a flow sensor signal into a linear 4 – 20 mA signal. Electronic signal dampening, computer programmable, compact size in a metal enclosure. Power input, 9-35 VDC/0-1 kHz, 75 ohms at 24 VDC, accuracy of 0.1% of full scale. Manufacturer: Kele Model 310-02, Universal Flow Transmitter Model UFT-1.
- 5. Liquid Leak Detection System: Kele, Raychem, Trace Tek.
 - a. Mechanical float devices attached to or inserted within the auxiliary pan are not acceptable.
 - b. Sensor shall be activated when there is at least ¼ inch of water, but no more than ½ inch of water in the auxiliary pan.
 - c. Equal to Kele Model AQS00661 water detector.
- E. HUMIDITY TRANSMITTERS
 - 1. Units shall be suitable for duct, wall (room) or outdoor mounting. Unit shall be two-wire transmitter utilizing bulk polymer resistance change or thin film capacitance change humidity sensor. Unit shall produce linear continuous output of 4-20 mA for percent relative humidity (%RH). A combination temperature and humidity sensor may be used for zone level monitoring. Sensors shall have the following minimum performance and application criteria:
 - a. Input Range: 0 – 100% RH
 - b. Accuracy (%RH): +/- 2% (when used for enthalpy calculation, dewpoint calculation or humidifier control) or +/- 3% (monitoring only) between 20-90%RH at 77°F, including hysteresis, linearity, and repeatability.
 - c. Sensor Operating Range: As required by application.
 - d. Long Term Stability: Less than 1% drift per year.
 - 2. Acceptable Manufacturers: Units shall be Vaisala HM Series, General Eastern, Microline, or Hy-Cal HT Series.
- 2.6 CONTROL VALVES
 - A. Valves shall be rated for a minimum of 150 percent (150%) of system operating pressure at the valve location but not less than 125 psig.
 - B. 2" and Smaller: Valves shall be bronze body with screwed or flared connections.
 - C. 2-1/2" and Larger: Valves shall be bronze or iron body, flanged.
 - D. Flow characteristics:
 - 1. Three-way valves shall have a linear relation of flow vs. valve position.

2. Two-way valve position vs. flow relation shall be equal percentage for water flow control.

E. Maximum pressure drop through valve:

1. Modulating water flow control: 1/2 the pressure drop through the apparatus with maximum of 10 feet of water. Two position water valves shall be line size.

2.7 CONTROL DAMPERS

A. The ATC Sub-contractor shall furnish all the controlled dampers of the type and sizes indicated on the drawings for installation by the sheet metal Sub-contractor.

B. All 2-position control dampers shall be parallel blade and sized for minimum pressure drop, at the specified duct size.

C. All modulating dampers shall be opposed blade and sized for an effective linear air flow control characteristics within the angle of rotation and maximum pressure drops specified. Information shall be provided to the sheet metal Subcontractor for determining the proper duct reductions or baffles used.

D. Damper frames shall not be less than 16-gauge galvanized steel, formed with corner braces for extra strength, with mounting holes for enclosed duct mounting.

E. All damper blades shall be of not less than 16-gauge galvanized steel formed for strength and high velocity performance. Blades on all dampers must not be over 8" in width. Blades shall be secured to 1/2" diameter zinc plated axles by zinc plated bolts and nuts. All blade bearings shall be nylon or oilite. Blade side edges shall be sealed off against spring stainless steel seals. Teflon coated thrust bearings shall be provided at each end of every blade to minimize torque requirements and insure smooth operation. All blade leakage hardware shall be constructed of corrosion resistant, zinc plated steel and brass.

F. Dampers shall be suitable for operation between -40 and 200 degrees. The control manufacturer shall submit leakage and flow characteristics plus a size schedule for all controlled dampers.

G. All blade edges shall have inflatable seal edging that shall be rated for leakage less than 10 cubic feet per minute per square foot of damper area at a differential pressure of 4" of water when the damper is being held by a torque not to exceed 50 inert lbs. Leakage shall not exceed 1/2 of 1% of total flow.

H. Provide permanent mark or scribe end of drive shaft to align damper with actuator in closed position.

2.8 CONTROL CABINETS

A. Control cabinets shall be constructed of 18-gauge steel with locking hinged door. Unless otherwise specified, all controllers, electric relays, switches and other equipment furnished as part of the control system which are not required to be mounted on mechanical equipment, shall be cabinet mounted. The temperature indicators and switches shall be flush mounted on the door tagged with plastic labels. All electrical devices shall be wired to a numbered terminal strip and all devices shall be completely adjusted and checked for proper operation prior to shipment to job site. All wiring shall be numbered according to the control diagram.

2.9 SEQUENCE OF OPERATION: High School / Performing Arts Center

A. Host Computer and Operator's Work Station (OWS)

1. The host computer and accessories shall be located in Cust. Office 125D or as directed by the Owner. The computer and all peripheral equipment shall be furnished by the Owner.

2. Coordinate required capacity and features with the Owner's IT representative.

3. All control programs and application features shall reside in the OWS.

4. Control manufacturer shall provide subsequent levels of control capability to whatever extent necessary to achieve performance required for individual units in their respective local control panels. All ATC panels shall be wired to the nearest source of power at 277/1. Coordinate with

the work of Division 26 – Electric.

5. Work with the Owner to establish occupied/unoccupied schedules and setpoints. Enter the schedules and setpoints into the system. Provide the required number of input/output points to achieve the specified sequences of operation and monitoring points.
6. Work with the Owner to determine which points shall be trended and the sampling frequency. Set up the trend logs in the BAS.

B. Dual Temperature Loop Summer/Winter Changeover Control:

1. The BAS shall provide control of summer/winter changeover. Provide two-way control valves in the boiler room and throughout the piping system to isolate the hot water and chilled water systems, as well as heating-only terminal units in the building. Blocking valves shall be actuated open/closed with failure to last controlled position.
2. Summer Mode:
 - a. When the system is manually put in the “summer” mode, the isolation control valves shall be positioned to allow chilled water into the dual temperature loop and to isolate the hot water boilers and heating terminal units from the dual temperature loop. Before the chilled water isolation valves open, the dual temperature loop temperature must be below the programmed setpoint of 88°F, adjustable, in order to prevent damage to the chiller as well as condensation in the heating units.
 - b. Provide an end switch on each valve actuator. The chilled water system shall not be activated until the isolation valves are in the proper position. Display the end switch positions at the OWS. If the valve’s end switch does not coincide with the commanded position of the valve, provide an alarm at the OWS and lock out the chiller start sequence.
3. Winter Mode:
 - a. When the system is manually put in the “winter” mode, the isolation control valves shall be positioned to isolate the chiller from the dual temperature loop while opening the hot water system isolation valves and terminal heating unit isolation valves to the dual temperature loop. Before isolation valves open, the dual temperature loop temperature must be above the programmed setpoint of 65°F (adj.).
 - b. Provide an end switch on each valve actuator. The hot water system shall not be activated until the isolation valves are in the proper position. Display the end switch positions at the OWS. If a given valve’s end switch does not coincide with the commanded position of the valve, provide an alarm at the OWS and lock out the boilers start sequence.
4. Loop changeover shall be subject to manual selection based on schedule, loop temperature and outside air temperature, all adjustable.
5. If the dual temperature loop supply temperature sensor does not detect hot or chilled water being supplied to the building equipment, the units shall be disabled. In “heating mode,” supply water temperature should be above 90°F (adj.). In “cooling mode,” the temperature should be below 65°F (adj.).
6. The following items shall be displayed at the OWS:
 - a. Graphical display of the dual temperature system and related piping.
 - b. Current system setting – summer/winter.
 - c. End switch status for each isolation valve.
 - d. Commanded status for each isolation valve.
 - e. Isolation valve failure status.
 - f. Outside air temperature, global.

- g. Outside air temperature setpoints for automatic changeover.
- h. Dual temperature loop discharge and return temperatures.
- i. Chilled water system supply and return temperatures.
- j. Hot water system supply and return temperatures.

C.1 Heating System Control:

1. This system consists of two boilers, B-C1 and B-C2, each with boiler circulating pumps P-C3 and P-C4, primary loop isolation valves, and building dual temperature heating/cooling pumps P-C1 and P-C2. Each boiler is equipped with a burner suitable of using natural gas.
 - a. Each boiler's combustion system shall be controlled by its integral burner controls. The boilers shall be activated/de-activated via the BAS based on outdoor air temperature, or via manual command at the OWS. Once activated, the boilers' integral controls shall maintain setpoint of the system (140°F, adj.).
2. Whenever the outdoor air temperature is at or below 50°F, adjustable, boilers B-C1 shall be enabled and B-C2 shall be on standby. On a call for boiler B-C1 to operate, the system isolation valves shall be commanded open, Article 'F', on a proof of open via valve end switch the boiler shall be enabled. B-C2 shall remain in standby. If boiler B-C1 cannot maintain hot water supply setpoint boiler B-C2 shall be enabled to operate. The BAS shall stage the boilers to maintain optimum efficiency and hot water supply temperature at setpoint.
3. The boiler control panel shall provide boiler modulation, boiler pump operation, and diagnostics. The BAS shall monitor boiler inlet/outlet, and outside air temperature.
4. When the boiler's integral controls are activated, Pump P-C3 or P-C4 shall be activated, and the system isolation valves shall open (proven). A current switch on one phase of power feeding the boiler pumps shall monitor flow status at the OWS. If pump operation is not indicated, and the boiler did not fire or isolation valves open, deactivate the boiler and activate the second (back-up) boiler; generate a boiler alarm at the OWS.
 - a. The BAS shall receive a general boiler failure alarm from a set of dry contacts, which are provided by the boiler manufacturer. This alarm shall be annunciated at the OWS.
 - b. The BAS shall rotate the lead and lag boiler/pump set to equalize the accumulated run time.
5. A winter boiler freeze setpoint will activate boiler sequence regardless of time schedule whenever outdoor temperature drops below 32°F (adj.).
6. Provide hot water discharge and return temperature sensors for each boiler.
7. BAS Contractor shall provide all field control wiring for control panels, header temperature sensors, and boiler controller.
8. Provide system software in the OWS to monitor and trend weather and building response time to initiate morning warm-up cycles in sufficient time to establish occupied space temperatures before actual occupancy occurs.
9. The following items shall be displayed at the OWS:
 - a. Graphical display of the boilers, pumps, and related piping.
 - b. Boiler activated/de-activated status, each boiler.
 - c. Boiler failure, each boiler.
 - d. Outside air temperature.
 - e. Outside air temperature setpoint for boiler activation (adjustable).
 - f. Boiler discharge temperature, each boiler.

- g. Boiler return temperature, each boiler.
- h. Pump water flow status/alarm, each pump via current switch.
- i. Status of each isolation valve: open/closed.
- j. Primary loop pump flow status/alarm: via VFD alarm/status contact and frequency feedback signal.

C.2 Make-Up Water Monitoring System Control

1. Provide system control for the make-up water serving the dual temp heating and cooling system in the Penthouse.
2. Provide a water flow meter on the make-up water supply. When the measured flow exceeds 10 gallons/minute, adjustable, close the normally open solenoid valve, generate an alarm at the OWS, and shut down the boilers, pumps, chiller, and auxiliaries affected.
3. Flow sensor, consisting of a removable flow sensor mounted in a cast-bronze housing, available in ½" to 1-1/2" pipe size. Sensor shall be rated for a flow range of 0.5 to 15 feet per second, 220°F max., 400 psig at 100°F maximum pressure; Nylon impeller, Pennlon bearing, tungsten carbide shaft, PPS housing and EPDM seals. Manufacturer: Kele Model 250B.
4. Programmable analog flow transmitter shall be a loop-powered device that converts a flow sensor signal into a linear 4 – 20mA signal, with electronic signal dampening, computer programmable, and compact size in a metal enclosure. Power input, 9-35 VDC/0-1 kHz, 75 ohms at 24 VDC, accuracy of 0.1% of full scale. Manufacturer: Kele Model 310-02.
5. The following items shall be displayed at the OWS:
 - a. Water flow in gallons per minute.
 - b. Command signal to the valve.
 - c. High flow/equipment shut down alarm.

D. Primary Dual Temperature Heating/Cooling Water Pumps Control:

1. Pumps P-C1 and P-C2 shall be controlled directly by the BAS per a lead/lag sequence with the designated lead pump alternated on a minimum weekly basis, or as reset at the OWS. The designated lead pump shall be activated as part of the heating or cooling water system. The pumps shall also be subject to a manual command at the OWS.
 - a. Each pump shall be provided with a VFD as part of the work of Division 26 - Electric. The VFD on the pump shall ramp up its speed to maintain the balance of water in the system.
 - b. A water sensor shall be installed 2/3 of the way along the dual temp piping to monitor water flow. Provide differential pressure switches on each floor of Area 'J'.
 - c. Provide a current sensor on the load wire of the VFD for flow status monitoring and alarming.
2. Monitor flow status via VFD alarm/status contact and frequency feedback signal at the OWS.
3. Once activated, the designated lead pump shall run continuously. If the lead pump fails, after a 20 second time-delay, the lag pump shall be energized after an alarm is sent to the OWS. After the cause of the failure is corrected, a manual command from the OWS is required to restore normal operation.
4. The designated lead pump shall be enabled whenever the building heating or cooling system is activated, as programmed through the BAS.
 - a. When the system is manually put in the "winter" mode, the lead pump shall operate through its variable speed drive to provide full flow equal to 60 Hertz on the drive output. The pump speed shall change in response to system pressure changes as described in Paragraph 1.a as

terminal unit two-way control valves close off to the system.

- b. When the system is manually put in the “summer” mode, the lead pump shall operate through its variable speed drive to provide full flow equal to the scheduled chiller evaporator gpm. Coordinate this calibration point during the TAB agenda of the work.
5. The following items shall be displayed at the OWS:
 - a. Graphical display of pumps and related piping.
 - b. Outside air temperature.
 - c. Designated lead and lag pumps (i.e.: Pump P-C1 Lead - Pump P-C2 Lag).
 - d. Pump command start/stop.
 - e. Commanded status of each pump via VFD alarm/status contact and frequency feedback signal.
 - f. Flow status/alarm via differential pressure switch.
 - g. Dual temperature loop discharge and return temperature.
- E. Chilled Water System Control:
 1. This system consists of one air-cooled water chiller, CH-C1, dual temperature loop pumps P-C1 and P-C2, and interconnecting piping and accessories. Chiller shall start/stop as programmed by the BAS. Pumps P-C1 and P-C2 shall be controlled directly by the BAS per a lead/lag sequence as described in article D.
 2. When the system is scheduled to operate and outdoor air temperature is at or above the programmed setpoint of 60°F, adjustable, system control sequence shall be activated. The system can also be manually activated via a software switch at the OWS. Additionally, the chilled water system activation shall be subject to the summer/winter changeover sequence described under ‘Dual Temperature Isolation Valves’.
 3. When the chiller control sequence is activated, the lead pump shall be energized. When water flow is proven through each pump, via a current switch, the chiller’s factory controller shall be activated to maintain its integral setpoint of 44°F, adjustable.
 - a. Chiller controller shall activate factory installed heat tape on the evaporator whenever chiller is off and outside air temperature is at or below 35°F, adjustable. Verify setting and operation per chiller manufacturer’s written instructions.
 4. The BAS shall limit the chiller on-time to a minimum of 10 minutes. The minimum off-time for the chiller shall be 20 minutes. Timing set-points are adjustable, and final setting must be approved by the chiller manufacturer.
 5. The OWS shall be able to interface all inputs, monitor alarms, and change setpoints.
 6. The BAS shall monitor chilled water discharge and return temperatures for display at the OWS.
 7. BAS Contractor shall provide all field control wiring for operation of the chiller.
 8. The following items shall be displayed at the OWS:
 - a. Graphic depicting equipment, piping layout and temperature control devices with dynamic display of each status, temperature, etc.
 - b. Chilled water discharge and return temperature at the chiller.
 - c. Common chilled water supply and return water temperatures.
 - d. Alarm/status inputs for chiller.
 - e. Chilled water pump start/stop command and status via current switch.
 - f. Chilled water pump flow/alarm per pump via current switch.

- g. Chiller on/off command and status.
 - h. Heat tape status.
- F. Dual Temperature Isolation Valves
 1. Furnish dual temperature isolation valves as shown on the drawings. During heating season, the hot water isolation valves shall be open to the dual temperature piping and the chilled water isolation valves shall be closed. During cooling season, the chilled water isolation valves shall be open and the hot water isolation valves shall be closed. Heating and cooling valves shall be commanded from separate and individual outputs. When switching between heating and cooling, implement an adjustable time delay initially set to 12 hours to allow the dual temperature loop to reach ambient temperature before mixing with primary systems. If any valve does not prove open via end switch, an alarm shall be displayed at OWS.
 2. The following items shall be displayed at the OWS:
 - a. Individual zones showing isolation control valves and commanded position.
 - b. Operator selection to set heating/cooling position of each isolation control valve of each zone.
- G. Domestic Water Heater System Control
 1. The domestic water heaters located in Mechanical Room C119 shall be activated by its integral temperature controls. The heater is equipped with sealed combustion air control which does not require any further control interface. The BAS to provide enable/disable control of heaters based on a time schedule.
 2. Provide a hot water discharge sensor for monitoring, high/low limit alarms for the heater and for the hot water circulating loop. The OWS shall receive a general status/failure alarm from the domestic water heater for monitoring and alarm generation at the OWS. Set the high/low limit alarms to suit system operation and water loop.
 3. Provide on/off control of the domestic hot water circulating pump based on a schedule furnished by the Owner. Provide a current switch on one phase of power to the pump for monitoring and alarm generation. If the pump is commanded on and flow is not detected, after a 20-second delay, provide an alarm at the OWS.
 4. The following items shall be displayed at the OWS:
 - a. Domestic water heater activated/deactivated.
 - b. Domestic hot water discharge temperature.
 - c. High/Low discharge temperature alarm, heater and loop.
 - d. General failure signal.
 - e. Commanded status of domestic hot water circulator pump.
 - f. Pump flow status/failure alarm.
- H1. HS Penthouse C401 Heating and Ventilation System Control
 1. This system consists of unit heaters UH-C4.1 and UH-C4.2, exhaust fan EF-C15, and an outside air intake. Provide motor operated dampers and actuators for control of exhaust and outside air in the room. Provide space temperature sensor as shown on the drawings.
 2. On a rise in space temperature above 80°F, adjustable, the exhaust air and outside air dampers shall open. Subject to a limit switch on the exhaust air damper, the exhaust fan shall start. On a fall in space temperature below setpoint, the fan shall be de-energized and all dampers shall close.
 3. On a fall in space temperature below 60°F, adjustable, room sensor shall energize the fan on the

- unit heater to run and open the hot water control valve. On a rise in space temperature, the reverse shall occur.
4. The following items shall be displayed at the OWS:
 - a. Space temperature.
 - b. Low temperature alarm, 40°F, adjustable.
 - c. High temperature alarm, 100°F, adjustable.
 - d. Heating setpoint.
 - e. Ventilation setpoint.
 - f. Commanded status of exhaust fan and dampers.
 - g. Commanded status of unit heater fan.
 - h. Commanded status of control valve.

H.2 MER B122 Heating and Ventilation System Control

1. This system consists of unit heaters UH-B1.1 and UH-B1.2, roof mounted exhaust fan EF-B1, and outside air intake OA1-B1. Provide motor operated dampers and actuators for control of exhaust and outside air in the room. Provide space temperature sensor as shown on the drawings.
2. On a rise in space temperature above 80°F, adjustable, the exhaust air and outside air dampers shall open. Subject to a limit switch on the exhaust air damper, the exhaust fan shall start. On a fall in space temperature below setpoint, the fan shall be de-energized and all dampers shall close.
3. On a fall in space temperature below 60°F, adjustable, room sensor shall energize the fan on the unit heater to run and open the hot water control valve. On a rise in space temperature, the reverse shall occur.
4. The following items shall be displayed at the OWS:
 - a. Space temperature.
 - b. Low temperature alarm, 40°F, adjustable.
 - c. High temperature alarm, 100°F, adjustable.
 - d. Heating setpoint.
 - e. Ventilation setpoint.
 - f. Commanded status of exhaust fan and dampers.
 - g. Commanded status of unit heater fan.
 - h. Commanded status of control valve.

H.3 Scene Shop Storage B130A Heating and Ventilation System Control

1. This system consists of unit heater UH-B1.4, roof mounted exhaust fan EF-B4, and outside air intake OA1-B2. Provide motor operated dampers and actuators for control of exhaust and outside air in the room. Provide space temperature sensor as shown on the drawings.
2. On a rise in space temperature above 80°F, adjustable, the exhaust air and outside air dampers shall open. Subject to a limit switch on the exhaust air damper, the exhaust fan shall start. On a fall in space temperature below setpoint, the fan shall be de-energized and all dampers shall close.
3. On a fall in space temperature below 60°F, adjustable, room sensor shall energize the fan on the unit heater to run and open the hot water control valve. On a rise in space temperature, the reverse shall occur.

4. The following items shall be displayed at the OWS:
 - a. Space temperature.
 - b. Low temperature alarm, 40°F, adjustable.
 - c. High temperature alarm, 100°F, adjustable.
 - d. Heating setpoint.
 - e. Ventilation setpoint.
 - f. Commanded status of exhaust fan and dampers.
 - g. Commanded status of unit heater fan.
 - h. Commanded status of control valve.

H4. Mech. C168 Heating and Ventilation System Control

1. This system consists of unit heater UH-C1.6, exhaust fan EF-C23, and an outside air intake. Provide motor operated dampers and actuators for control of exhaust and outside air in the room. Provide space temperature sensor as shown on the drawings.
2. On a rise in space temperature above 80°F, adjustable, the exhaust air and outside air dampers shall open. Subject to a limit switch on the exhaust air damper, the exhaust fan shall start. On a fall in space temperature below setpoint, the fan shall be de-energized and all dampers shall close.
3. On a fall in space temperature below 60°F, adjustable, room sensor shall energize the fan on the unit heater to run and open the hot water control valve. On a rise in space temperature, the reverse shall occur.
4. The following items shall be displayed at the OWS:
 - a. Space temperature.
 - b. Low temperature alarm, 40°F, adjustable.
 - c. High temperature alarm, 100°F, adjustable.
 - d. Heating setpoint.
 - e. Ventilation setpoint.
 - f. Commanded status of exhaust fan and dampers.
 - g. Commanded status of unit heater fan.
 - h. Commanded status of control valve.

I. Fan Coil Unit Control

1. Each unit shall be controlled by an individual DDC Controller. The DDC Controller shall be provided by ATC and field installed. The DDC Controller shall be wired to a space temperature sensor with setpoint adjustment and override switch (Microtouch). Provide all sensors required for operation, monitoring, and control of each unit; interface with the 24-volt control transformer furnished with the unit. Provide a 2-way control valve for the dual temperature coil for installation by the Mechanical Contractor.
 - a. Provide a flat-plate space sensor for units serving stairways; no override switch is required in these locations.
2. During the programmed occupied mode, the fan shall run continuously. OWS shall be able to override fan from constant operation to cycle fan.
 - a. Provide motor operated dampers and actuators for units which are directly connected to a source of outside air for ventilation. Each damper shall open fully during the occupied mode and remain closed during the unoccupied mode.

- b. Heating mode: On a fall in space temperature below the programmed heating setpoint of 70°F, adjustable, the coil control valve shall modulate open to the coil. On a rise in space temperature, the valve shall modulate closed. The valve shall be under further control of a high limit discharge air temperature sensor with setpoint at 100°F, adjustable, to prevent damage to the unit's components. Provide an alarm at the OWS if the discharge air temperature rises above the high limit setpoint.
 - c. Cooling mode: On a rise in space temperature above the programmed cooling setpoint of 75°F, adjustable, the coil control valve shall modulate open. On a fall in space temperature, the valve shall modulate closed to the coil.
- 3. During the programmed unoccupied mode when boiler or chiller is OFF (pending mode of operation). The supply fan shall be de-energized and the control valve closed. During the programmed unoccupied mode when boiler or chiller is ON (pending mode of operation), the supply fan and control valve shall operate as follows: the fan shall cycle and the control valve shall modulate in sequence to maintain the programmed unoccupied space temperature setpoints of 60°F (heating) and 85°F (cooling), all adjustable. When the override switch on the room sensor is activated, the unit shall be controlled as outlined in item 2 above for a minimum 2-hour period, adjustable at the OWS. Once the override cycle times out, the unit shall reset to the unoccupied mode of operation.
 - 4. If the discharge temperature fails to rise to a programmed minimum temperature during a call for heating, a low temperature alarm shall be activated at the OWS. If the discharge temperature fails to fall to a programmed minimum temperature on a call for cooling, a high temperature alarm shall be activated at the OWS.
 - 5. Provide a current switch on one phase of power feeding the supply fan for status indication at the OWS.
 - 6. Provide a condensate sensor in the auxiliary drain pan below each unit. When condensate is detected in the pan, close the coil control valve, deactivate the unit supply fan, and provide an alarm at the OWS.
 - 7. The following items shall be displayed at the OWS:
 - a. Global outside air temperature.
 - b. Space temperature.
 - c. Space temperature setpoint.
 - d. Discharge temperature.
 - e. High and low limit discharge air setpoints.
 - f. Commanded status of fan.
 - g. Operational status of fan via current switch.
 - h. Commanded status of each control valve.
 - i. Low discharge temperature alarm.
 - j. High discharge temperature alarm.
 - k. Condensate alarm.
 - l. Commanded status of outside air damper.
 - m. Diagram showing the layout of the unit with major components and dynamic temperatures shown where temperature sensors exist in the system.

J.1 Hot Water Cabinet Unit Heater Control

- 1. Each cabinet unit heater shall be controlled by the BAS via a space temperature sensor.

- a. Provide a separate DDC controller and flat plate space sensor for each unit; no override switch is required.
 - b. Provide a 2-way, hot water control valve for installation in the unit by the Mechanical Contractor.
2. During the programmed occupied mode, the unit fan shall cycle. On a fall in space temperature below the programmed setpoint of 65°F, adjustable, the hot water coil control valve shall open. On a rise in temperature above setpoint, the valve shall close.
3. During the programmed unoccupied mode when boiler is OFF, the fan shall be de-energized and the control valve closed. During the programmed unoccupied mode when boiler is ON, the fan and control valve shall operate as follows: The fan shall cycle and the hot water control shall open to maintain the programmed temperature setpoint of 60°F, adjustable.
4. If the discharge temperature fails to rise to a programmed minimum temperature during a call for heating, a low temperature alarm shall be activated at the OWS.
5. Provide a current switch on one phase of power feeding the supply fan for status indication at the OWS.
6. The following items shall be displayed at the OWS:
 - a. Space temperature.
 - b. Space temperature setpoint.
 - c. Discharge temperature.
 - d. Commanded status of fan.
 - e. Operational status of fan via current switch.
 - f. Commanded status of control valve.
 - g. Low discharge temperature alarm.
 - h. Diagram showing the layout of the unit with major components and dynamic temperatures shown where temperature sensors exist in the system.

J.2. Hot Water Unit Heater Control

1. Each unit heater shall be controlled by the BAS via a space temperature sensor.
 - a. Provide a separate DDC controller and flat plate space sensor for each unit; no override switch is required.
2. The unit fan shall cycle to maintain the programmed setpoint of 65°F, adjustable.
3. Provide a current switch on one phase of power feeding the unit fan for status indication at the OWS.
4. The following items shall be displayed at the OWS:
 - a. Space temperature.
 - b. Space temperature setpoint.
 - c. Commanded status of fan.
 - d. Operational status of fan via current switch.
 - e. Commanded status of control valve.

J.3. Zone Hot Water Heating Duct Coil Control

1. Duct coils shall be controlled by an individual DDC Controller and space temperature sensor. Provide space sensor and two-way control valve for each coil.
2. Sensor shall modulate the heating coil control valve to maintain space temperature at 75°F,

adjustable.

3. The following items shall be displayed at the OWS:

- a. Space temperature.
- b. Space temperature setpoint.
- c. Discharge air temperature.
- d. Commanded status of control valve.

J.4. Hot Water Finned Tube Radiation Control:

1. The finned tube radiation shall be controlled by a two-way, hot water control valve.
2. Provide a control valve and actuator for installation in piping for each unit or group of units. Provide a blank plate stainless steel sensor for each unit or group of units in one room. Valve shall open/close to maintain space temperature of 65°F, adjustable.
3. The following items shall be displayed at the OWS:
 - a. Space temperature
 - b. Space temperature setpoint
 - c. Commanded status of control valve.

K.1. Electric Cabinet Unit Heater Control:

1. Each cabinet unit heater shall be controlled by the BAS via a space temperature sensor.
 - a. Provide a separate DDC controller and flat plate space sensor for each unit; no override switch is required.
2. During the programmed occupied mode, the unit fan shall cycle. On a fall in space temperature below the programmed setpoint of 65°F, adjustable, the electric heater shall be energized. On a rise in temperature above setpoint, the heater shall de-energize.
3. During the programmed unoccupied mode when boiler is OFF, the fan and heater shall be de-energized. During the programmed unoccupied mode when boiler is ON, the fan and heater shall operate as follows: The fan shall cycle and the heater energized to maintain the programmed temperature setpoint of 60°F, adjustable.
4. If the discharge temperature fails to rise to a programmed minimum temperature during a call for heating, a low temperature alarm shall be activated at the OWS.
5. Provide a current switch on one phase of power feeding the supply fan for status indication at the OWS.
6. The following items shall be displayed at the OWS:
 - a. Space temperature.
 - b. Space temperature setpoint.
 - c. Discharge temperature.
 - d. Commanded status of fan.
 - e. Operational status of fan via current switch.
 - f. Commanded status of heater.
 - g. Low discharge temperature alarm.
 - h. Diagram showing the layout of the unit with major components and dynamic temperatures shown where temperature sensors exist in the system.

K.2. Electric Panel Radiation Control:

1. The electric radiation shall be controlled by the BAS via a space temperature sensor.
 - a. Provide a blank plate stainless steel sensor for each unit or group of units in one room.
 2. On a fall in space temperature below the programmed setpoint of 65°F, adjustable, during the occupied mode, the electric heater shall be energized. On a rise in temperature above setpoint, the heater shall de-energize.
 3. During the programmed unoccupied mode when boiler is OFF, the heater shall be de-energized. During the programmed unoccupied mode when boiler is ON, the heater shall operate as follows: The heater shall be energized to maintain the programmed temperature setpoint of 60°F, adjustable.
 4. The following items shall be displayed at the OWS:
 - a. Space temperature
 - b. Space temperature setpoint
 - c. Commanded status of heater.
- L. Ductless Split System Unit/Split System Heat Pump Control:
1. The following sequence is typical for all of the systems scheduled on the drawings.
 2. Each unit shall be controlled by its factory controls. Adjust factory controls to allow the indoor unit fan to cycle off once space temperature is achieved. Mount and wire the thermostat, which is furnished by the equipment manufacturer, and interlock the controls from the indoor unit to the outdoor unit. Set to maintain 75°F, adjustable. Provide interface to unit provided thermostat for control by Owner.
 3. Provide a space mounted temperature sensor for monitoring and alarm generation at the OWS. On a rise in space temperature above the programmed high limit setpoint of 80°F, adjustable, an alarm shall be activated. On a fall in space temperature below the programmed low limit setpoint of 50°F, adjustable, an alarm shall be activated.
 4. The following items shall be displayed at the OWS:
 - a. Space temperature.
 - b. High and low limit alarms and setpoints.
- M.1 Kitchen Hood Exhaust Fan Control:
1. The sequence that follows is typical for the following systems:
 - a. Culinary 1/2 Kitchen: EF-B12/hood K7, EF-B13/hood K7, and EF-B14/hood K7
 2. The hood exhaust fan shall be energized manually by an on/off switch provided as part of the hood. Interface with this switch in accordance with hood manufacturer's written instructions.
 3. The kitchen equipment manufacturer shall provide the BAS Contractor with wiring diagrams for the hood and all factory sensors.
 4. Whenever fan switch is engaged in the 'ON' position, the exhaust fan shall be energized.
 - a. Provide a current switch on one phase of the power feeding the exhaust fan.
 5. Interface with a common fire alarm input to the BAS system from the fire alarm system (FAS). The fire alarm contact shall be provided by the fire alarm system vendor at the FAS panel. The status of the alarm contact shall be communicated throughout the BAS. When the fire alarm contact indicates an alarm condition, the BAS shall de-energize the exhaust fan. NOTE: the FAS shall also shut down the unit whenever the room CO (carbon monoxide) detector goes into alarm.
 - a. If the kitchen ventilator exhaust fan is running and the hood fire suppression system is activated manually, the exhaust fan shall continue to run until deactivated by the FAS or

manually shut down at the hood.

6. The following items shall be displayed for each system at the OWS:
 - a. Fire alarm system status alarm.
 - b. Commanded status of fans.
 - c. Exhaust fan operational status via current switch.
 - d. Diagram showing the layout of the equipment with major components and dynamic temperatures shown where temperature sensors exist in the system.

M.2 Kitchen Hood Exhaust Fan & Make-Up Air Unit Control:

1. The sequence that follows is typical for the following systems:
 - a. Café. Kitchen: EF-B5, MAU-B3, and hood C21
 - b. Culinary 3/4 Kitchen: EF-B9, MAU-B1, and hood C25
 - c. Culinary 3/4 Kitchen: EF-B10, MAU-B2, and hood C55
2. The hood exhaust fan and make-up air unit shall be energized manually by an on/off switch provided as part of the hood. Interface with this switch in accordance with hood manufacturer's written instructions.
 - a. Mount the remote temperature sensor furnished with the hood as per manufacturer.
3. The kitchen equipment manufacturer shall provide the BAS Contractor with wiring diagrams for the hood and all factory sensors.
4. The following items shall be provided by the make-up air unit manufacturer:
 - a. Motor starter and overload protection.
 - b. Outside air damper and actuator with end switch.
 - c. Remote control panel.
 - d. Terminal blocks for all wiring connections between equipment and control devices.
5. Whenever fan switch is engaged in the 'ON' position, the exhaust fan and make-up air supply fan shall be energized.
 - a. Provide a current switch on one phase of the power feeding the exhaust fan. When current is sensed, indicating that the exhaust fan has been energized, the make-up air unit outside air damper shall open 100% and the supply fan shall be energized.
 - b. On a fall in discharge air temperature below setpoint of 65°F, adjustable, the gas heat shall stage and modulate through its unit-mounted controls to maintain setpoint. Discharge air temperature shall be manually adjustable through the remote-control panel furnished with the makeup air unit.
 - c. The supply fan shall not be energized until the damper is in the open position. Display the end switch position at the OWS. If the end switch does not coincide with the commanded position, provide an alarm at the OWS.
6. Provide a current switch on one phase of power feeding the supply fan for monitoring and alarm generation at the OWS.
7. The system shall prevent the circulation of smoke. Upon activation of the duct smoke detector in the supply air ducts in the vicinity of the hood, the unit shall stop and all dampers shall close. The Mechanical Contractor shall install duct smoke detector furnished as part of the work of Division 26 – Electric.
8. Interface with a common fire alarm input to the BAS system from the fire alarm system (FAS). The fire alarm contact shall be provided by the fire alarm system vendor at the FAS panel. The

status of the alarm contact shall be communicated throughout the BAS. When the fire alarm contact indicates an alarm condition, the BAS shall de-energize the supply fan, exhaust fan, gas heat and damper motors. When de-energized, the damper motor shall spring return the outside air damper closed. NOTE: the FAS shall also shut down the unit whenever the room CO (carbon monoxide) detector goes into alarm.

- a. If the kitchen ventilator exhaust fan is running and the hood fire suppression system is activated manually, the exhaust fan shall continue to run until deactivated by the FAS or manually shut down at the hood.
 - b. The MAU shall shut down whenever the hood suppression system or fire alarm system is activated. Provide interface with each system.
9. The following items shall be displayed for each system at the OWS:
- a. Discharge air temperature.
 - b. Discharge air temperature setpoint.
 - c. Discharge low limit alarm.
 - d. Fire alarm system status alarm.
 - e. Commanded status of fans and damper.
 - f. Supply fan operational status via current switch.
 - g. Exhaust fan operational status via current switch.
 - h. Smoke detector status/alarm.
 - i. Diagram showing the layout of the equipment with major components and dynamic temperatures shown where temperature sensors exist in the system.

M.3 Dishwasher Exhaust Fan Control

1. This system consists of EF-B11 serving the condensate hood in Culinary 3/4 Kitchen.
 2. Provide a motor operated damper and actuator as shown on the drawings. The damper shall be installed by the Mechanical Contractor. Fan shall run subject to a limit switch on the exhaust air damper, once activated.
 3. Provide a current switch on one phase of power feeding the dishwasher unit. Upon activation of the dishwasher, the exhaust fan shall start and run as long as the dishwasher is energized.
 4. Provide a current switch on one phase of power feeding the fan for status indication at the OWS.
5. The following items shall be displayed at the OWS:
- a. Fan status via current switch: on/off/alarm.
 - b. Commanded status of fan and damper.

M.4 Dishwash Area Exhaust Fan Control:

1. The sequence that follows is typical for EF-B7 & EF-B8 serving the Café Kitchen.
2. Exhaust fan shall be energized manually through a switch provided as part of the work of Division 26 – Electric.
3. Provide a motor operated damper and actuator for control of the exhaust air shown on the drawings.
4. Once activated by the switch, and subject to a limit switch on the exhaust air damper, the fan shall run continuously and motor operated damper in exhaust duct shall open. When fan is de-energized, the reverse shall occur.
5. Provide a current switch on one phase of power feeding the fan for status indication at the OWS.

6. Interface with a common fire alarm input to the BAS system from the fire alarm system (FAS). Whenever the FAS indicates an alarm condition while the fan is running, the BAS shall deenergize the fan and close the exhaust air damper.
7. The following items shall be displayed at the OWS:
 - a. Fan status via current switch: On/Off/Alarm.
 - b. Commanded status of fan and damper.

M.5 Exhaust Fan Control

1. The sequence that follows is typical for fans EF-B4, B8, C5, C13, C14, C16, C17, C22, and C23. Coordinate occupied/unoccupied scheduling with owner.
2. Provide a motor operated damper and actuator for the exhaust fan as shown on the drawings. The damper shall be installed by the Mechanical Contractor.
3. Exhaust fan shall be energized during the occupied period and de-energized during the unoccupied period via the BAS. The damper shall be open during the occupied mode and shall be closed during the unoccupied mode.
4. Subject to a limit switch on the exhaust air damper, the fan shall run continuously during the occupied mode.
5. Provide a current switch on one phase of power feeding the fan for status indication at the OWS.
6. Interface with a common fire alarm input to the BAS system from the fire alarm system (FAS). When the FAS indicates an alarm condition, the BAS shall de-energize the fan and close the exhaust air damper.
7. The following items shall be displayed at the OWS:
 - a. Fan status via current switch: on/off/alarm.
 - b. Commanded status of fan and damper.

M.6 Bio/Anatomy Lab Exhaust Fan Control:

1. The sequence that follows is typical for EF-C6, C7, C8, and C9.
2. Exhaust fan shall be energized manually through a switch provided as part of the work of Division 26 – Electric.
3. Provide a motor operated damper and actuator for control of the exhaust air as shown on the drawings.
4. Provide a motor operated damper and actuator for the branch exhaust air duct in each lab as shown on the drawings.
5. Once activated by the switch, and subject to a limit switch on the exhaust air damper, the fan shall run continuously and motor operated damper in the exhaust duct shall open. The exhaust damper in the branch duct shall close. When fan is de-energized, the exhaust fan damper shall close and the branch exhaust damper shall open.
6. Provide a current switch on one phase of power feeding the fan for status indication at the OWS.
7. Interface with a common fire alarm input to the BAS system from the fire alarm system (FAS). Whenever the FAS indicates an alarm condition while the fan is running, the BAS shall deenergize the fan and close the exhaust air damper.
8. The following items shall be displayed at the OWS:
 - a. Fan status via current switch: On/Off/Alarm.
 - b. Commanded status of exhaust fan and damper.

- c. Commanded status of branch exhaust air duct damper.

M.7 Chemistry Lab Hood Exhaust Fan Control:

1. The sequence that follows is typical for EF-C10, C11, and C12.
2. Exhaust fan shall be energized manually through a switch located on the face of the lab hood. Division 26 – Electrical shall interface fan with manual switch.
3. Provide a motor operated damper and actuator for control of the exhaust air as shown on the drawings.
4. Provide a motor operated damper and actuator for the branch exhaust air duct in each lab as shown on the drawings.
5. Once activated by the switch, and subject to a limit switch on the exhaust air damper, the fan shall run continuously and motor operated damper in the exhaust duct shall open. The exhaust damper in the branch duct shall close. When fan is de-energized, the exhaust fan damper shall close and the branch exhaust damper shall open.
6. Provide a current switch on one phase of power feeding the fan for status indication at the OWS. Calibrate switch between no load and full load amps to detect a broken drive belt.
7. Provide an alarm light on face of hood near the fan switch with laminated red/white/red placard which reads: 'DANGER WHEN RED' in minimum 3/8" high letters. Light shall reset once fan operation is corrected.
8. If the fan is on when the fire alarm system is activated, fan shall continue to operate.
9. The following items shall be displayed at the OWS:
 - a. Fan status via current switch: On/Off/Alarm.
 - b. Commanded status of exhaust fan and damper.
 - c. Commanded status of branch exhaust air duct damper.

M.8 Exhaust Fan Control: EF-C1 STEM LAB C112 & EF-C2 FITNESS C173

1. Exhaust fan shall be energized manually through a switch provided as part of the work of Division 26 – Electric.
2. Provide a motor operated damper and actuator for control of the exhaust air as shown on the drawings.
3. Provide a motor operated damper and actuator for the branch exhaust air duct in each lab as shown on the drawings.
4. Once activated by the switch, and subject to a limit switch on the exhaust air damper, the fan shall run continuously and motor operated damper in the exhaust duct shall open. The exhaust damper in the branch duct shall close. When fan is de-energized, the exhaust fan damper shall close and the branch exhaust damper shall open.
5. Provide a current switch on one phase of power feeding the fan for status indication at the OWS.
6. Interface with a common fire alarm input to the BAS system from the fire alarm system (FAS). Whenever the FAS indicates an alarm condition while the fan is running, the BAS shall deenergize the fan and close the exhaust air damper.
7. The following items shall be displayed at the OWS:
 - a. Fan status via current switch: On/Off/Alarm.
 - b. Commanded status of exhaust fan and damper.
 - c. Commanded status of branch exhaust air duct damper.

M.9 Area L Laundry Ventilation Control

1. Provide a motor operated damper and actuator for control of the outside air as shown on the drawings to support the commercial laundry dryer in the space.
2. Provide a current switch on one phase of power to monitor operation of the laundry dryer.
3. Current switch shall activate the outside air damper whenever the dryer is energized. When the dryer is de-energized, the damper shall close.
4. The following items shall be displayed at the OWS:
 - a. Commanded status of damper.

M.10 Area L Uniform Storage Ventilation Control

1. This system consists of unit heater UH-C1.2, exhaust fan EF-C3, and an outside air intake duct. Provide motor operated dampers and actuators for control of exhaust and outside air in the room. Provide space temperature sensor as shown on the drawings.
2. On a rise in space temperature above 80°F, adjustable, the exhaust air and outside air dampers shall open. Subject to a limit switch on the exhaust air damper, the exhaust fan shall start. On a fall in space temperature below setpoint, the fan shall be de-energized and all dampers shall close.
3. On a fall in space temperature below 60°F, adjustable, room sensor shall energize the fan on the unit heater to run. On a rise in space temperature, the reverse shall occur.
4. The following items shall be displayed at the OWS:
 - a. Space temperature.
 - b. Low temperature alarm, 40°F, adjustable.
 - c. High temperature alarm, 100°F, adjustable.
 - d. Heating setpoint.
 - e. Ventilation setpoint.
 - f. Commanded status of exhaust fan and dampers.
 - g. Commanded status of unit heater fan.

M.11 Area L Athletic Storage Ventilation Control

1. This system consists of unit heater UH-C1.4 and C1.5, exhaust fan EF-C4, and an outside air intake duct. Provide motor operated dampers and actuators for control of exhaust and outside air in the room. Provide space temperature sensor as shown on the drawings.
2. On a rise in space temperature above 80°F, adjustable, the exhaust air and outside air dampers shall open. Subject to a limit switch on the exhaust air damper, the exhaust fan shall start. On a fall in space temperature below setpoint, the fan shall be de-energized and all dampers shall close.
3. On a fall in space temperature below 60°F, adjustable, room sensor shall energize the fan on the unit heater to run. On a rise in space temperature, the reverse shall occur.
4. The following items shall be displayed at the OWS:
 - a. Space temperature.
 - b. Low temperature alarm, 40°F, adjustable.
 - c. High temperature alarm, 100°F, adjustable.
 - d. Heating setpoint.
 - e. Ventilation setpoint.
 - f. Commanded status of exhaust fan and dampers.

- g. Commanded status of unit heater fan.

M.12 Smoke Management Exhaust Fan Control:

1. The following sequence is typical for EF-C18, C19, C20, and C21.
2. Exhaust fan shall be energized manually through a switch in the Smoke Management Control Panel located in the Fire Pump Room B121.
3. Provide a motor operated damper and actuator for control of the exhaust air as shown on the drawings.
4. Once activated by the switch, and subject to a limit switch on the exhaust air damper, the fan shall run continuously and motor operated damper in the exhaust duct shall open. When fan is de-energized, the exhaust fan damper shall close.
5. Provide a current switch on one phase of power feeding the fan for status indication at the OWS.
6. The following items shall be displayed at the OWS:
 - a. Fan status via current switch: On/Off/Alarm.
 - b. Commanded status of exhaust fan and damper.

N. Energy Recovery Unit Control

1. The following sequence is typical for eleven units as scheduled on the drawings. Each unit consists of supply fan, exhaust fan, packaged DX cooling system, hot gas reheat for dehumidification, package indirect fired gas heating system, energy recovery wheel and drive, filters, air control dampers and actuators, drives for each fan, and unit controls. Each unit is a constant volume system with 100% outside air and economizer mode of operation.
2. The ERU shall be controlled by an individual DDC Controller. The BAS Contractor shall provide the DDC Controller and all required sensors which shall include, but are not limited to, a discharge air temperature sensor, exhaust air temperature sensor, return air temperature sensor, return air humidity sensor, and global outside air temperature and humidity sensors.
3. The equipment manufacturer shall provide the BAS Contractor with wiring diagrams for the equipment. The BAS Contractor shall then provide wiring diagrams to the equipment manufacturer detailing installation and wiring requirements for the DDC Controls. All ATC work shall be field mounted and wired.
4. The system shall maintain occupied/unoccupied schedule according to its programmed schedule or the reset manually by the BAS. Delay startup of the unit until the zone temperature has recovered from its previous setback or setup temperature during the unoccupied mode. Time schedules shall be coordinated with and approved by owner prior to implementing.
5. Once activated, supply fan, exhaust fan, and energy recovery wheel shall run continuously with the outside air and exhaust air dampers open. The gas fired heating section and DX cooling systems shall be staged in sequence to maintain the minimum return air temperature setpoint of 70°F, adjustable, in the return air duct based on a temperature sensor at the unit return. On a rise in discharge air temperature, the DX cooling system will be staged to provide cooling. On a fall in temperature, the reverse shall occur.
 - a. The supply fan and exhaust fan shall not be energized until the damper is in the open position. Display the end switch position at the OWS. If the end switch does not coincide with the commanded position, provide an alarm at the OWS.
 - b. When the unit is deactivated, the fans, heating and cooling shall be off and all dampers shall be closed.
6. The economizer sequence shall be activated as the first stage of cooling. The DDC controller shall receive input from the global outdoor air temperature sensor. Whenever outdoor air

- temperature is below 57°F (adj.), the economizer control shall be enabled. On a rise above 62°F (adj.), the economizer control shall be disabled. When activated, the energy wheel shall stop and the economizer bypass damper shall open fully.
7. Whenever outdoor air temperature is below 55 deg. F (adj.), the DX cooling shall be locked out from operating. Whenever outdoor air is above 55 deg. F (adj.), the gas heating shall be locked out from operating.
 8. The cooling and hot gas reheat shall be activated to maintain return air humidity. On a rise in return air humidity above the setpoint of 65%, adjustable, the cooling shall be energized at 100% capacity. On a drop in return air temperature below the setpoint of 70 deg. F, adjustable, the hot gas reheat shall be energized to reheat the space. On a rise in return air temperature to the setpoint, the hot gas reheat shall be deactivated. On a fall in return air humidity below the adjustable setpoint, the cooling shall be deactivated.
 9. During the unoccupied mode, the supply and exhaust fan shall stop, the energy recovery wheel shall stop, and outside air and exhaust dampers shall close.
 10. The DDC controller shall receive input from the unit's factory installed energy wheel rotation sensor for monitoring and alarm generation at the OWS.
 - a. Unit shall continue to run in manual mode until the unit is shut down manually or at the OWS whenever the energy wheel fails.
 - b. Whenever the outside air temperature is +/- 5°F, adjustable, of return air temperature in the unit, the energy recovery wheel shall stop.
 11. Interface with a common fire alarm input from the fire alarm system. The fire alarm contact shall be provided at the fire alarm panel by the fire alarm contractor. The status of the alarm contact shall be communicated throughout the BAS. When the fire alarm contact indicates an alarm condition, the BAS shall de-energize the unit. When de-energized, the damper motors shall spring return the outside and exhaust air dampers closed. Provide an alarm at the OWS to indicate fire alarm status. NOTE: the FAS shall also shut down the unit whenever a classroom CO (carbon monoxide) detector goes into alarm.
 12. The Mechanical Contractor shall install duct smoke detectors in the supply and return air ducts at the unit as furnished by the FAS vendor as part of the work of Division 26 – Electric. When wired to the fire alarm system as required by the Division 26 contractor, the duct smoke detectors shall alarm the FAS, which shall signal the BAS to de-energize the unit in a manner similar to item 11.
 13. Provide a refrigerant leak detector within the ERU at the DX coil. If a leak is detected, the BAS shall de-energize the unit and provide an alarm at the OWS.
 14. The following items shall be displayed at the OWS:
 - a. Discharge air temperature.
 - b. Discharge air temperature setpoint.
 - c. Return air temperature.
 - d. Return air humidity.
 - e. Exhaust air temperature.
 - f. Fire alarm system status/alarm.
 - g. Supply and exhaust fan start/stop command and speed signal.
 - h. Supply fan operational status via a current switch.
 - i. Exhaust fan operational status via a current switch.

- j. Energy recovery wheel commanded status, operational status via current sensor and alarm.
- k. Smoke detector status/alarm.
- l. Room CO detector status: Normal/Alarm
- m. Damper command position of all damper actuators.
- n. Global OA temperature and humidity.
- o. Refrigerant leak detector status/alarm.
- p. Diagram showing the layout of the equipment with major components and dynamic temperatures shown where temperature sensors exist in the system.

O.1 Packaged Rooftop Unit Control: General

1. The sequence that follows is typical for RTU-B1, B3, B4, B5, C1, C2, C3, C6, C7, and C8 as scheduled on the drawings. Each unit consists of a supply fan, packaged air-cooled DX cooling system, hot gas reheat for dehumidification, gas fired heating section, air filters, air control dampers and actuators.
 - a. Each unit is a constant volume system with minimum outside air and economizer mode of operation.
 - b. Each unit shall be controlled by an individual DDC Controller. The DDC Controller shall be wired to sensors which shall include, but are not limited to, a discharge air temperature sensor, mixed air temperature sensor, return air temperature sensor, global outside air temperature/humidity/enthalpy, CO2 sensors, and a combination space temperature/humidity sensor. The DDC Controller and all required sensors shall be provided by the BAS Contractor, field mounted and wired.
2. The following items shall be provided by the equipment manufacturer:
 - a. Overload protection.
 - b. Control transformers.
 - c. Dampers and damper motors.
 - d. Terminal blocks for all wiring connections between equipment and control devices.
 - e. Standard factory control modules for unit DX and natural gas functions.

The following items shall be provided by ATC:

- a. Space temperature sensors.
 - b. Space humidity sensor or combination space temperature/humidity sensor.
 - c. Discharge air temperature sensor.
 - d. Return air temperature sensor.
 - e. Return air humidity sensor.
 - f. Global outside air temperature and humidity sensors.
 - g. Current sensor for one phase of the power feeding the fan.
 - h. Mixed air average temperature sensor.
 - i. CO2 sensors and space temperature sensors. (Note: RTU-B1 does not require CO2 sensor).
 - j. DDC Controller.
3. During the programmed occupied mode, the supply fan shall run continuously with the outside air damper closed. When fan fails to start once activated, initiate an alarm to the system after a twenty second delay. Monitor fan status with a current switch on one leg of power feeding the fan motor. Delay opening the outside air damper to its minimum position until the zone space

- temperature has recovered from the setback or setup temperature setting. Each fan shall have the ability to cycle on/off with a call for heating or cooling.
- a. Outside air damper shall remain closed until return air CO₂ level rises to 700 ppm. The outside air damper shall step open from its minimum position to full scheduled open position to maintain CO₂ level at or below 700 ppm. The return air and relief air dampers in the system shall modulate in unison to maintain the balance of air in the system.
 - b. On a continued rise in CO₂ level above 900 ppm, activate an alarm at the OWS. On a decrease in CO₂ level below 700 ppm, the outside air damper shall step to minimum position.
4. On a drop-in space air temperature below the programmed setpoint of 70°F, adjustable, the unit gas heating section shall be activated and stage to maintain setpoint. Use space sensors to maintain average temperature setting.
 5. On a rise in space air temperature above setpoint, the mixing box economizer sequence shall be activated. On a further rise or if the economizer sequence is deactivated, the unit air-cooled DX system shall be activated to maintain setpoint. On a fall in temperature the reverse shall occur. Maintain 75°F, adjustable.
 6. The economizer sequence shall be activated as the first stage of cooling. The DDC Controller shall receive input from the global outside air temperature sensor. Whenever outdoor air temperature is below 57°F (adj.), the economizer control shall be enabled. On a rise above 62°F (adj.), the economizer control shall be disabled. The mixing box dampers shall maintain a mixed air temperature of 50°F (adj.).
 7. Whenever outdoor air temperature is below 55 deg. F (adj.), the DX cooling shall be locked out from operating. Whenever outdoor air is above 55 deg. F (adj), the gas heating shall be locked out from operating.
 8. On a rise in space humidity level above setpoint, 65% (adj.), the dehumidification sequence shall be activated, whereby the electric heater shall be energized by the BAS or the cooling shall be activated at 100% capacity, while the electric reheat is energized by the BAS. If the unit is already in DX cooling mode, the electric reheat will be energized. On a fall in space humidity below the adjust able setpoint, the dehumidification mode shall be deactivated.
 9. During the programmed un-occupied mode, the fan, heating, cooling hot gas reheat, and mixing box dampers shall be cycled/modulated to maintain the un-occupied setpoints of 60°F (heating), 85°F (cooling), and 65% dehumidification, all adjustable. Unless required for economizer cycle, the outside air and relief air dampers shall remain closed with the return air damper fully open.
 10. Interface with a common fire alarm input from the fire alarm system. The fire alarm contact shall be provided at the fire alarm panel by the Fire Alarm Contractor. The status of the alarm contact shall be communicated throughout the BAS. When the fire alarm contact indicates an alarm condition, the BAS shall de-energize the unit. When de-energized, the damper motors shall spring return the outside and relief air dampers closed. Provide an alarm at the OWS to indicate fire alarm status. NOTE: the FAS shall also shut down the unit whenever the room CO (carbon monoxide) detector goes into alarm.
 11. The Mechanical Contractor install duct smoke detectors in the supply and return air ducts at the unit as furnished by the FAS vendor as part of the work of Division 26 – Electric. When wired to the fire alarm system as required by the Division 26 contractor, the duct smoke detectors shall alarm the FAS, which shall signal the BAS to de-energize the unit in a manner similar to item 109.
 12. Provide a refrigerant leak detector within the AHU at the DX coil. If a leak is detected, the BAS shall de-energize the unit and provide an alarm at the OWS.

13. The following items shall be displayed at the OWS:

- a. Space temperature and setpoint.
- b. Space humidity percentage and setpoint.
- c. Supply air temperature.
- d. Return air temperature.
- e. Return air humidity.
- f. Mixed air temperature.
- g. Mixed air temperature setpoint.
- h. Global outside air temperature, humidity and enthalpy.
- i. Fire alarm system status/alarm.
- j. Duct smoke detectors status: normal/alarm.
- k. Commanded status of fan.
- l. Supply fan operational status via current switch.
- m. Commanded status of dampers.
- n. Room CO detector status: normal/alarm.
- o. Refrigerant leak detector status/alarm.
- p. Diagram showing the layout of the equipment with major components and dynamic temperatures shown where temperature sensors exist in the system.

O.2 Rooftop Unit Control

1. The sequence that follows is typical for system RTU-B6/RF-B1, RTU-B7/RF-B2, and RTU-C5/RF-C2 as scheduled on the drawings. The rooftop unit consists of a supply fan, packaged air-cooled DX cooling system, hot gas reheat for dehumidification, gas fired heating section, air filters, air control dampers and actuators with an inline return air fan.
 - a. Each unit is a constant volume system with minimum outside air and economizer mode of operation.
 - b. Each unit shall be controlled by an individual DDC Controller. The DDC Controller shall be wired to sensors which shall include, but are not limited to, a discharge air temperature sensor, mixed air temperature sensor, return air temperature sensor, global outside air temperature/humidity/enthalpy, CO2 sensors, and a combination space temperature/humidity sensor. The DDC Controller and all required sensors shall be provided by the BAS Contractor, field mounted and wired.
 - c. Interlock unit with its duct mounted return air fan.
2. The following items shall be provided by the equipment manufacturer:
 - a. Overload protection.
 - b. Control transformers.
 - c. Dampers and damper motors.
 - d. Terminal blocks for all wiring connections between equipment and control devices.
 - e. Standard factory control modules for unit DX and natural gas functions.
 - f. Motor starter and overload protection for the return fan shall be provided as part of the work of Division 26 – Electric.

The following items shall be provided by ATC:

- a. Space temperature sensors.
 - b. Space humidity sensor or combination space temperature/humidity sensor.
 - c. Discharge air temperature sensor.
 - d. Return air temperature sensor.
 - e. Return air humidity sensor.
 - f. Global outside air temperature and humidity sensors.
 - g. Current sensor for one phase of the power feeding the fan.
 - h. Mixed air average temperature sensor.
 - i. CO2 sensors and space temperature sensors.
 - j. DDC Controller.
3. During the programmed occupied mode, the supply and return air fans shall run continuously with the outside air damper closed. When either fan fails to start once activated, initiate an alarm to the system after a twenty second delay. Monitor fans status with a current switch on one leg of power feeding the fan motors. Delay opening the outside air damper to its minimum position until the zone space temperature has recovered from the setback or setup temperature setting. Each fan shall have the ability to cycle on/off with a call for heating or cooling.
 - a. Outside air damper shall remain closed until return air CO2 level rises to 700 ppm. The outside air damper shall step open from it's minimum position to full scheduled open position to maintain CO2 level at or below 700 ppm. The return air and relief air dampers in the system shall modulate in unison to maintain the balance of air in the system.
 - b. On a continued rise in CO2 level above 900 ppm, activate an alarm at the OWS. On a decrease in CO2 level below 700 ppm, the outside air damper shall step to minimum position.
4. For RTU-C5 only, the space temperature reading of the units associated hot water duct coils temperature sensor will be polled and averaged to control RTU's heating/cooling operation. A user selectable checkbox will be located on the OWS to manually remove any room temperature sensor from the polling control logic.
5. On a drop-in space air temperature (average space temperature for RTU-C5 only) below the programmed setpoint of 70°F, adjustable, the unit gas heating section shall be activated and stage to maintain setpoint. Use space sensors to maintain average temperature setting.
6. On a rise in space air temperature (average space temperature for RTU-C5 only) above setpoint, the mixing box economizer sequence shall be activated. On a further rise or if the economizer sequence is deactivated, the unit air-cooled DX system shall be activated to maintain setpoint. On a fall in temperature the reverse shall occur. Maintain 75°F, adjustable.
7. The economizer sequence shall be activated as the first stage of cooling. The DDC controller shall receive input from the global outside air temperature sensor. Whenever outdoor air temperature is below 57°F (adj.), the economizer control shall be enabled. On a rise above 62°F (adj.), the economizer control shall be disabled. The mixing box dampers shall maintain a mixed air temperature of 50°F (adj.).
8. Whenever outdoor air temperature is below 55 deg. F (adj.), the DX cooling shall be locked out from operating. Whenever the outdoor air is above 55 deg. F (adj.), the gas heating shall be locked out from operating.
9. On a rise in space humidity level above setpoint, 65% (adj.), the dehumidification sequence shall be activated, whereby the electric heater shall be energized by the BAS or the cooling shall be activated at 100% capacity, while the electric reheat is energized by the BAS. If the unit is

- already in DX cooling mode, the electric reheat will be energized. On a fall in space humidity below the adjustable setpoint, the dehumidification mode shall be deactivated.
10. During the programmed un-occupied mode, the fans, heating, cooling, hot gas reheat, and mixing box dampers shall be cycled/modulated to maintain the un-occupied setpoints of 60°F (heating), 85°F (cooling), and 65% dehumidification, all adjustable. Unless required for economizer cycle, the outside air and relief air dampers shall remain closed with the return air damper fully open.
 11. Space temperature sensors utilized for unit RTU-C5 control will have their override program enabled. The space temperature sensors contain an unoccupied override button. Pressing the button will initiate a 2-hour (adj.) occupied period. When the period has elapsed, the unit will operate as defined in the above unoccupied mode.
 12. For RTU-C5 only, the space temperature sensor TS1 wired to the unit's controller will be used for temperature control if a communication failure occurs with the associated DC-x room temperature sensor.
 13. Interface with a common fire alarm input from the fire alarm system. The fire alarm contact shall be provided at the fire alarm panel by the Fire Alarm Contractor. The status of the alarm contact shall be communicated throughout the BAS. When the fire alarm contact indicates an alarm condition, the BAS shall de-energize the unit and inline return air fan. When de-energized, the damper motors shall spring return the outside and relief air dampers closed. Provide an alarm at the OWS to indicate fire alarm status. NOTE: the FAS shall also shut down the unit whenever the room CO (carbon monoxide) detector goes into alarm.
 14. The Mechanical Contractor install duct smoke detectors in the supply and return air ducts at the unit as furnished by the FAS vendor as part of the work of Division 26 – Electric. When wired to the fire alarm system as required by the Division 26 contractor, the duct smoke detectors shall alarm the FAS, which shall signal the BAS to de-energize the unit in a manner similar to item 13.
 15. Provide a refrigerant leak detector within the AHU at the DX coil. If a leak is detected, the BAS shall de-energize the unit and provide an alarm at the OWS.
 16. The following items shall be displayed at the OWS:
 - a. Space temperature and setpoint.
 - b. Space humidity percentage and setpoint.
 - c. Supply air temperature.
 - d. Return air temperature.
 - e. Return air humidity.
 - f. Mixed air temperature.
 - g. Mixed air temperature setpoint.
 - h. Global outside air temperature, humidity and enthalpy.
 - i. Fire alarm system status/alarm.
 - j. Duct smoke detectors status: normal/alarm.
 - k. Commanded status of fan.
 - l. Supply fan operational status via current switch.
 - m. Commanded status of dampers.
 - n. Room CO detector status: normal/alarm.
 - o. Refrigerant leak detector status/alarm.
 - p. Diagram showing the layout of the equipment with major components and dynamic

temperatures shown where temperature sensors exist in the system.

O.3 Rooftop Unit with Energy Recovery Control: RTU-C4.

1. This unit is equipped with supply fan, exhaust fan, packaged DX cooling system, hot gas reheat for dehumidification, packaged indirect gas-fired heating section, filters, an energy recovery wheel and drive, filters, air control dampers and actuators, drives for each fan, and unit controls. This unit is a constant volume system with 100% outside air and economizer mode of operation.
 - a. The unit shall be controlled by an individual DDC Controller. The DDC Controller shall be wired to sensors which shall include, but are not limited to, a discharge air temperature sensor, mixed air temperature sensor, return air temperature sensor, global outside air temperature/humidity/enthalpy, and space temperature/humidity sensor. The DDC Controller and all required sensors shall be provided by the BAS Contractor, field mounted and wired.
2. During the unoccupied mode, the unit outside air, relief air damper, and energy wheel bypass dampers shall close (unless unit operates in economizer mode), the energy recovery wheel shall stop, the return air damper shall open, and the fans shall stop. The system shall maintain its scheduled setup or setback temperatures. The BAS system shall activate the rooftop unit supply fan and activate the gas-fired heating section or DX cooling section. Once the zone sensor is satisfied, the unit shall shut down.
 - a. During the programmed un-occupied mode, the supply fan, gas heating, and DX cooling shall be cycled/modulated to maintain the un-occupied setpoints of 60°F (heating) and 85°F (cooling), all adjustable. The outside air, relief air, and bypass dampers shall remain closed (unless unit operates in economizer mode) with the return air damper fully open. The exhaust fan shall remain off.
3. Prior to changeover to the occupied mode, the BAS system shall activate the rooftop unit, start the supply fan, and stage the gas-fired heating section or DX cooling section to restore the zone to heating setpoint of 70 °F, adjustable, or to cooling setpoint of 75°F, adjustable.
4. The outside air damper shall open to its minimum positions, return air and relief air dampers shall open, bypass damper shall close, exhaust fan shall start, and the energy recovery wheel shall start.
5. The Controller shall activate the DX cooling section and gas heating section to maintain space air temperature.
 - a. Whenever the outside air temperature is +/- 5 °F, adjustable, of return air temperature in the unit, the energy recovery wheel shall stop and bypass damper shall open.
 - b. On a drop in space temperature below the programmed setpoint of 70°F, adjustable, the unit gas heating section will be activated to maintain setpoint.
 - c. On a rise in space temperature above setpoint, the mixing box economizer sequence shall be activated as the first stage of cooling. The DDC Controller shall receive input from the global outside air temperature sensor. Whenever outdoor air temperature is below 57°F (adj.), the economizer control shall be enabled. The mixing box dampers shall maintain a mixed air temperature of 50 °F (adj.). On a rise above 62 °F (adj.), the economizer control shall be disabled and the units DX system will be activated.
 - d. Whenever outdoor air temperature is below 55°F, adj., the DX cooling shall be locked out from operating. Whenever outdoor air temperature is above 55°F, adj., the gas heating shall be locked out from operating.
 - e. The DDC controller shall receive input from the unit's factory installed energy wheel rotation sensor for monitoring and alarm at the OWS. Unit shall continue to run in manual mode until the unit is shut down manually or at the OWS whenever the energy wheel fails.

6. On a rise in space humidity level above setpoint, 65% (adj.), the dehumidification sequence shall be activated, whereby the dehumidification terminal shall be energized by the BAS or the cooling shall be activated at 100% capacity, while the hot gas reheat is energized by the BAS. If the unit is already in DX cooling mode, the hot gas reheat will be energized. On a fall in space humidity below the adjustable setpoint, the dehumidification mode shall be deactivated.
7. Interface with a common fire alarm input from the fire alarm system. The fire alarm contact shall be provided at the fire alarm panel by the fire alarm contractor. The status of the alarm contact shall be communicated throughout the BAS. When the fire alarm contact indicates an alarm condition, the BAS shall de-energize the unit. When de-energized, the damper motors shall spring all air dampers closed. Provide an alarm at the BAS to indicate fire alarm status. NOTE: the FAS shall also shut down the unit whenever the room CO (carbon monoxide) detector goes into alarm.
8. The Mechanical Contractor shall install duct smoke detectors in the supply and return air ducts at the unit as furnished by the FAS vendor as part of the work of Division 26 – Fire Alarm System. When wired to the fire alarm system as required by the Division 26 contractor, the duct smoke detectors shall alarm the FAS, which shall signal the BAS to de-energize the unit in a manner similar to item 7.
9. Provide a refrigerant leak detector within the AHU at the DX coil. If a leak is detected, the BAS shall de-energize the unit and provide an alarm at the OWS.
10. The following items shall be displayed at the BAS:
 - a. Space temperature and setpoint.
 - b. Space humidity percentage and setpoint.
 - c. Supply air temperature.
 - d. Mixed air temperature.
 - e. Mixed air temperature setpoint.
 - f. Return air temperature
 - g. Return air humidity.
 - h. Exhaust air temperatures
 - i. Fire alarm system status/alarm.
 - j. Commanded status of fans.
 - k. Supply fan operational status via current switch.
 - l. Exhaust fan operational status via current switch.
 - m. Energy recovery wheel commanded status and alarm.
 - n. Smoke detector status/alarm.
 - o. Room CO detector status: Normal/Alarm
 - p. Refrigerant leak detector status/alarm.
 - q. Global OA temperature/humidity/enthalpy
 - r. Diagram showing the layout of the equipment with major components and dynamic temperatures shown where temperature sensors exist in the system.

O.4 Wrestling System Control: AHU-C1/ACC-C1 and RF-C1

1. This system consists of a modular air handling unit with a supply fan, DX cooling coil, dual temp heating/cooling coil, electric heater for dehumidification, and filter/mixing box with dampers; an air cooled remote condensing unit; and inline return fan. Provide actuators for control of outside

- air and return air. Provide a motor operated damper and actuator for control of exhaust air as shown on drawings.
- a. Each air handling unit is a constant volume system with minimum outside air and economizer mode of operation.
 - b. Each unit shall be controlled by an individual DDC Controller. The DDC Controller shall be wired to sensors which shall include, but are not limited to, a discharge air temperature sensor, mixed air temperature sensor, return air temperature sensor, global outside air temperature/humidity/enthalpy, CO2 sensors, and a combination space temperature/humidity sensor. The DDC Controller and all required sensors shall be provided by the BAS Contractor, field mounted and wired.
2. During the programmed occupied mode, the supply and return fans shall run continuously with the outside air damper closed. When either fan fails to start once activated, initiate an alarm to the system after a twenty second delay. Monitor fan status with a current switch on one leg of power feeding each fan motor. Delay opening the outside air damper to its minimum position until the zone space temperature has recovered from the setback or setup temperature setting. Each fan shall have the ability to cycle on/off with a call for heating or cooling.
 - a. Outside air damper shall remain closed until return air CO2 level rises to 700 ppm. The outside air damper shall step open from its minimum position to full scheduled open position to maintain CO2 level at or below 700 ppm. The return air and exhaust air dampers in the system shall modulate in unison to maintain the balance of air in the system.
 - b. On a continued rise in CO2 level above 900 ppm, activate an alarm at the OWS. On a decrease in CO2 level below 700 ppm, the outside air damper shall step to minimum position.
 3. On a drop-in space air temperature below the programmed setpoint of 70°F, adjustable, the dual temp heating control valve shall modulate open to maintain setpoint. If there is a call for cooling while the schools in the heating season, the hot water control valve shall close and cooling shall be provided via economizer or DX cooling.
 4. On a rise in space air temperature above setpoint, the mixing box economizer sequence shall be activated. On a further rise or if the economizer sequence is deactivated, the dual temp cooling control valve shall modulate open to maintain setpoint. On a fall in temperature the reverse shall occur. Maintain 75°F, adjustable. If chilled water is not available, the DX cooling shall be energized.
 5. The economizer sequence shall be activated as the first stage of cooling. The DDC Controller shall receive input from the global outside air temperature sensor. Whenever outdoor air temperature is below 57°F (adj.), the economizer control shall be enabled. On a rise above 62°F (adj.), the economizer control shall be disabled. The mixing box dampers shall maintain a mixed air temperature of 50°F (adj.).
 6. On a rise in space humidity level above setpoint, 65% (adj.), the dehumidification sequence shall be activated, whereby the electric heater shall be energized by the BAS or the cooling shall be activated at 100% capacity, while the electric reheat is energized by the BAS. If the unit is already in DX cooling mode, the electric reheat will be energized. On a fall in space humidity below the adjustable setpoint, the dehumidification mode shall be deactivated.
 7. During the programmed un-occupied mode, the fans, heating, cooling and mixing box dampers shall be cycled/modulate to maintain the un-occupied setpoints of 60°F (heating) and 85°F (cooling), all adjustable. Unless required for economizer cycle, the outside air and exhaust air dampers shall remain closed with the return air damper fully open.
 8. Interface with a common fire alarm input from the fire alarm system. The fire alarm contact shall

- be provided at the fire alarm panel by the Fire Alarm Contractor. The status of the alarm contact shall be communicated throughout the BAS. When the fire alarm contact indicates an alarm condition, the BAS shall de-energize the unit and fan. When de-energized, the damper motors shall spring return the outside and exhaust air dampers closed.
9. The Mechanical Contractor install duct smoke detectors in the supply and return air ducts at the unit as furnished by the FAS vendor as part of the work of Division 26 – Electric. When wired to the fire alarm system as required by the Division 26 contractor, the duct smoke detectors shall alarm the FAS, which shall signal the BAS to de-energize the unit in a manner similar to item 8.
 10. Provide a refrigerant leak detector within the AHU at the DX coil. If a leak is detected, the BAS shall de-energize the unit and provide an alarm at the OWS.
 11. The following items shall be displayed at the OWS:
 - a. Space temperature and setpoint.
 - b. Space humidity percentage and setpoint.
 - c. Supply air temperature.
 - d. Return air temperature.
 - e. Return air humidity.
 - f. Mixed air temperature.
 - g. Mixed air temperature setpoint.
 - h. Global outside air temperature, humidity and enthalpy.
 - i. Fire alarm system status/alarm.
 - j. Duct smoke detectors status: normal/alarm.
 - k. Commanded status of fans.
 - l. Supply fan operational status via current switch.
 - m. Commanded status of dampers.
 - n. Room CO detector status: normal/alarm.
 - o. Refrigerant leak detector status/alarm.
 - p. Diagram showing the layout of the equipment with major components and dynamic temperatures shown where temperature sensors exist in the system

O.5 Auxiliary Gym System Control: AHU-C2/ACC-C2 and RF-C3

1. This system consists of a modular air handling unit with a supply fan, DX cooling coil, dual temp heating/cooling coil, electric heater for dehumidification, and filter/mixing box with dampers; an air cooled remote condensing unit; and inline return fan. Provide actuators for control of outside air and return air. Provide a motor operated damper and actuator for control of exhaust air as shown on drawings.
 - a. Each air handling unit is a constant volume system with minimum outside air and economizer mode of operation.
 - b. Each unit shall be controlled by an individual DDC Controller. The DDC Controller shall be wired to sensors which shall include, but are not limited to, a discharge air temperature sensor, mixed air temperature sensor, return air temperature sensor, global outside air temperature/humidity/enthalpy, CO2 sensors, and a combination space temperature/humidity sensor. The DDC Controller and all required sensors shall be provided by the BAS Contractor, field mounted and wired.
2. During the programmed occupied mode, the supply and return fans shall run continuously with

- the outside air damper closed. When either fan fails to start once activated, initiate an alarm to the system after a twenty second delay. Monitor fan status with a current switch on one leg of power feeding each fan motor. Delay opening the outside air damper to its minimum position until the zone space temperature has recovered from the setback or setup temperature setting. Each fan shall have the ability to cycle on/off with a call for heating or cooling.
- a. Outside air damper shall remain closed until return air CO₂ level rises to 700 ppm. The outside air damper shall step open from its minimum position to full scheduled open position to maintain CO₂ level at or below 700 ppm. The return air and exhaust air dampers in the system shall modulate in unison to maintain the balance of air in the system.
 - b. On a continued rise in CO₂ level above 900 ppm, activate an alarm at the OWS. On a decrease in CO₂ level below 700 ppm, the outside air damper shall step to minimum position.
3. On a drop-in space air temperature below the programmed setpoint of 70°F, adjustable, the dual temp heating control valve shall modulate open to maintain setpoint. If there is a call for cooling while the schools in the heating season, the hot water control valve shall close and cooling shall be provided via economizer or DX cooling.
 4. On a rise in space air temperature above setpoint, the mixing box economizer sequence shall be activated. On a further rise or if the economizer sequence is deactivated, the dual temp cooling control valve shall modulate open to maintain setpoint. On a fall in temperature the reverse shall occur. Maintain 75°F, adjustable. If chilled water is not available, the DX cooling shall be energized.
 5. The economizer sequence shall be activated as the first stage of cooling. The DDC Controller shall receive input from the global outside air temperature sensor. Whenever outdoor air temperature is below 57°F (adj.), the economizer control shall be enabled. On a rise above 62°F (adj.), the economizer control shall be disabled. The mixing box dampers shall maintain a mixed air temperature of 50°F (adj.).
 6. On a rise in space humidity level above setpoint, 65% (adj.), the dehumidification sequence shall be activated, whereby the electric heater shall be energized by the BAS or the cooling shall be activated at 100% capacity, while the electric reheat is energized by the BAS. If the unit is already in DX cooling mode, the electric reheat will be energized. On a fall in space humidity below the adjust able setpoint, the dehumidification mode shall be deactivated.
 7. During the programmed un-occupied mode, the fans, heating, cooling and mixing box dampers shall be cycled/modulate to maintain the un-occupied setpoints of 60°F (heating) and 85°F (cooling), all adjustable. Unless required for economizer cycle, the outside air and exhaust air dampers shall remain closed with the return air damper fully open.
 8. Interface with a common fire alarm input from the fire alarm system. The fire alarm contact shall be provided at the fire alarm panel by the Fire Alarm Contractor. The status of the alarm contact shall be communicated throughout the BAS. When the fire alarm contact indicates an alarm condition, the BAS shall de-energize the unit and fan. When de-energized, the damper motors shall spring return the outside and exhaust air dampers closed.
 9. The Mechanical Contractor install duct smoke detectors in the supply and return air ducts at the unit as furnished by the FAS vendor as part of the work of Division 26 – Electric. When wired to the fire alarm system as required by the Division 26 contractor, the duct smoke detectors shall alarm the FAS, which shall signal the BAS to de-energize the unit in a manner similar to item 8.
 10. Provide a refrigerant leak detector within the AHU at the DX coil. If a leak is detected, the BAS shall de-energize the unit and provide an alarm at the OWS.
 11. The following items shall be displayed at the OWS:

- a. Space temperature and setpoint.
 - b. Space humidity percentage and setpoint.
 - c. Supply air temperature.
 - d. Return air temperature.
 - e. Return air humidity.
 - f. Mixed air temperature.
 - g. Mixed air temperature setpoint.
 - h. Global outside air temperature, humidity and enthalpy.
 - i. Fire alarm system status/alarm.
 - j. Duct smoke detectors status: normal/alarm.
 - k. Commanded status of fans.
 - l. Supply fan operational status via current switch.
 - m. Commanded status of dampers.
 - n. Room CO detector status: normal/alarm.
 - o. Refrigerant leak detector status/alarm.
 - p. Diagram showing the layout of the equipment with major components and dynamic temperatures shown where temperature sensors exist in the system
- P. Outdoor Lighting Control:
1. Division 26 - Electric shall provide multiple lighting contactors for control of outdoor lighting. The lighting will be divided into two or more zones. The lighting contactors shall be located adjacent to each other as shown on the electrical drawings.
 2. Provide an outdoor, ambient light level sensor. During the programmed operation period, the outdoor lighting shall be activated when the outdoor ambient light level falls below the programmed setpoint. Each zone shall have independent light level setpoints and time schedules. Set time schedules and light level setpoints as directed by the owner. All time schedules and setpoints shall be adjustable at the OWS.
 3. The following items shall be displayed at the OWS:
 - a. Ambient light level.
 - b. Time schedule per zone.
 - c. Commanded status of each zone.
- Q. Biohazard Shut Down System Control:
1. Provide a biohazard shutdown system including an emergency shut down switch, a "normal" pilot light and an emergency pilot light. The switch/pilot light assembly shall be located in the Principal's Office C101K or as directed by the Owner. Provide labeling of all components.
 2. When the emergency switch is activated, a signal shall be sent to the BAS to shut down all air handling equipment and to close all outdoor air dampers controlled by the BAS in the entire school. Provide an alarm at the OWS when the switch is activated.
 3. The alarm shall be manually reset at the switch and at the OWS before normal system operation resumes.
 4. The status of switch/system – normal or alarm shall be displayed at the OWS.
- R. Blocking Valves
1. Furnish blocking valves as shown on the drawings. The purpose of the valves is to prevent

- chilled water from migrating through the piping to terminal heating only equipment when the system is in the cooling mode, since the equipment is not equipped for condensation. The valves shall be of the two-position type and will fail in the last position (no spring return).
2. For heating only equipment, when the dual temperature loop is in the heating mode, the blocking valves shall be open. When the dual temperature loop is in the cooling mode, the blocking valves shall be closed.
 3. An end switch on the valve actuator shall be monitored by the BAS to indicate that the valve is fully open. Provide an alarm at the OWS if the valve is commanded open but not proven open via the end switch.
 4. The following items shall be displayed at the OWS:
 - a. Individual blocking valves and commanded position.
 - b. Operator selection to set heating/cooling position of each valve.
 - c. Status of valve end switch/valve open position.
 - d. Alarm if valve is commanded open and end switch does not indicate that the valve is open.
- S. Cold Storage Monitoring Control:
1. Provide a space temperature sensor in each of the walk-in coolers and freezers located in the Kitchen and Culinary Kitchen.
 2. Provide high limit alarms at the OWS.
- T. Sump Pump Control:
1. Provide a DDC controller and enclosure.
 2. Monitor the sump pump panel status and alarm inputs.
- 2.10 SEQUENCE OF OPERATION: Middle School
- A. Host Computer and Operator's Work Station (OWS)
1. The host computer and accessories shall be located in Cust. Office 125D or as directed by the Owner. The computer and all peripheral equipment shall be furnished by the Owner.
 2. Coordinate required capacity and features with the Owner's IT representative.
 3. All control programs and application features shall reside in the OWS.
 4. Control manufacturer shall provide subsequent levels of control capability to whatever extent necessary to achieve performance required for individual units in their respective local control panels. All ATC panels shall be wired to the nearest source of power at 277/1. Coordinate with the work of Division 26 – Electric.
 5. Work with the Owner to establish occupied/unoccupied schedules and setpoints. Enter the schedules and setpoints into the system. Provide the required number of input/output points to achieve the specified sequences of operation and monitoring points.
 6. Work with the Owner to determine which points shall be trended and the sampling frequency. Set up the trend logs in the BAS.
- B. Dual Temperature Loop Summer/Winter Changeover Control:
1. The BAS shall provide control of summer/winter changeover. Provide two-way control valves in the boiler room and throughout the piping system to isolate the hot water and chilled water systems, as well as heating-only terminal units in the building. Blocking valves shall be actuated open/closed with failure to last controlled position.
 2. Summer Mode:
 - a. When the system is manually put in the "summer" mode, the isolation control valves shall be

positioned to allow chilled water into the dual temperature loop and to isolate the hot water boilers and heating terminal units from the dual temperature loop. Before the chilled water isolation valves open, the dual temperature loop temperature must be below the programmed setpoint of 88°F, adjustable, in order to prevent damage to the chiller as well as condensation in the heating units.

- b. Provide an end switch on each valve actuator. The chilled water system shall not be activated until the isolation valves are in the proper position. Display the end switch positions at the OWS. If the valve's end switch does not coincide with the commanded position of the valve, provide an alarm at the OWS and lock out the chiller start sequence.
3. Winter Mode:
 - a. When the system is manually put in the "winter" mode, the isolation control valves shall be positioned to isolate the chiller from the dual temperature loop while opening the hot water system isolation valves and terminal heating unit isolation valves to the dual temperature loop. Before isolation valves open, the dual temperature loop temperature must be above the programmed setpoint of 65°F (adj.).
 - b. Provide an end switch on each valve actuator. The hot water system shall not be activated until the isolation valves are in the proper position. Display the end switch positions at the OWS. If a given valve's end switch does not coincide with the commanded position of the valve, provide an alarm at the OWS and lock out the boilers start sequence.
4. Loop changeover shall be subject to manual selection based on schedule, loop temperature and outside air temperature, all adjustable.
5. If the dual temperature loop supply temperature sensor does not detect hot or chilled water being supplied to the building equipment, the units shall be disabled. In "heating mode," supply water temperature should be above 90°F (adj.). In "cooling mode," the temperature should be below 65°F (adj.).
6. The following items shall be displayed at the OWS:
 - a. Graphical display of the dual temperature system and related piping.
 - b. Current system setting – summer/winter.
 - c. End switch status for each isolation valve.
 - d. Commanded status for each isolation valve.
 - e. Isolation valve failure status.
 - f. Outside air temperature, global.
 - g. Outside air temperature setpoints for automatic changeover.
 - h. Dual temperature loop discharge and return temperatures.
 - i. Chilled water system supply and return temperatures.
 - j. Hot water system supply and return temperatures.

C.1 Heating System Control:

1. This system consists of two boilers, B-A1 and B-A2, each with boiler circulating pumps P-A3 and P-A4, primary loop isolation valves, and building dual temperature heating/cooling pumps P-A1 and P-A2. Each boiler is equipped with a burner suitable of using natural gas.
 - a. Each boiler's combustion system shall be controlled by its integral burner controls. The boilers shall be activated/de-activated via the BAS based on outdoor air temperature, or via manual command at the OWS. Once activated, the boilers' integral controls shall maintain setpoint of the system (140°F, adj.).

2. Whenever the outdoor air temperature is at or below 50°F, adjustable, boilers B-A1 shall be enabled and B-A2 shall be on standby. On a call for boiler B-A1 to operate, the system isolation valves shall be commanded open, Article 'F', on a proof of open via valve end switch the boiler shall be enabled. B-A2 shall remain in standby. If boiler B-A1 cannot maintain hot water supply setpoint boiler B-A2 shall be enabled to operate. The BAS shall stage the boilers to maintain optimum efficiency and hot water supply temperature at setpoint.
3. The boiler control panel shall provide boiler modulation, boiler pump operation, and diagnostics. The BAS shall monitor boiler inlet/outlet, and outside air temperature.
4. When the boiler's integral controls are activated, Pump P-A3 or P-A4 shall be activated, and the system isolation valves shall open (proven). A current switch on one phase of power feeding the boiler pumps shall monitor flow status at the OWS. If pump operation is not indicated, and the boiler did not fire or isolation valves open, deactivate the boiler and activate the second (back-up) boiler; generate a boiler alarm at the OWS.
 - a. The BAS shall receive a general boiler failure alarm from a set of dry contacts, which are provided by the boiler manufacturer. This alarm shall be annunciated at the OWS.
 - b. The BAS shall rotate the lead and lag boiler/pump set to equalize the accumulated run time.
5. A winter boiler freeze setpoint will activate boiler sequence regardless of time schedule whenever outdoor temperature drops below 32°F (adj.).
6. Provide hot water discharge and return temperature sensors for each boiler.
7. BAS Contractor shall provide all field control wiring for control panels, header temperature sensors, and boiler controller.
8. Provide system software in the OWS to monitor and trend weather and building response time to initiate morning warm-up cycles in sufficient time to establish occupied space temperatures before actual occupancy occurs.
9. The following items shall be displayed at the OWS:
 - a. Graphical display of the boilers, pumps, and related piping.
 - b. Boiler activated/de-activated status, each boiler.
 - c. Boiler failure, each boiler.
 - d. Outside air temperature.
 - e. Outside air temperature setpoint for boiler activation (adjustable).
 - f. Boiler discharge temperature, each boiler.
 - g. Boiler return temperature, each boiler.
 - h. Pump water flow status/alarm, each pump via current switch.
 - i. Status of each isolation valve: open/closed.
 - j. Primary loop pump flow status/alarm: via VFD alarm/status contact and frequency feedback signal.

C.2 Make-Up Water Monitoring System Control

1. Provide system control for the make-up water serving the dual temp heating and cooling system in the Penthouse.
2. Provide a water flow meter on the make-up water supply. When the measured flow exceeds 10 gallons/minute, adjustable, close the normally open solenoid valve, generate an alarm at the OWS, and shut down the boilers, pumps, chiller, and auxiliaries affected.
3. Flow sensor, consisting of a removable flow sensor mounted in a cast-bronze housing, available

- in ½” to 1-1/2” pipe size. Sensor shall be rated for a flow range of 0.5 to 15 feet per second, 220°F max., 400 psig at 100°F maximum pressure; Nylon impeller, Pennlon bearing, tungsten carbide shaft, PPS housing and EPDM seals. Manufacturer: Kele Model 250B.
4. Programmable analog flow transmitter shall be a loop-powered device that converts a flow sensor signal into a linear 4 – 20mA signal, with electronic signal dampening, computer programmable, and compact size in a metal enclosure. Power input, 9-35 VDC/0-1 kHz, 75 ohms at 24 VDC, accuracy of 0.1% of full scale. Manufacturer: Kele Model 310-02.
 5. The following items shall be displayed at the OWS:
 - a. Water flow in gallons per minute.
 - b. Command signal to the valve.
 - c. High flow/equipment shut down alarm.
- D. Primary Dual Temperature Heating/Cooling Water Pumps Control:
1. Pumps P-A1 and P-A2 shall be controlled directly by the BAS per a lead/lag sequence with the designated lead pump alternated on a minimum weekly basis, or as reset at the OWS. The designated lead pump shall be activated as part of the heating or cooling water system. The pumps shall also be subject to a manual command at the OWS.
 - a. Each pump shall be provided with a VFD as part of the work of Division 26 - Electric. The VFD on the pump shall ramp up its speed to maintain the balance of water in the system.
 - b. A water sensor shall be installed 2/3 of the way along the dual temp piping to monitor water flow. Provide differential pressure switches on each floor of Area ‘A’.
 - c. Provide a current sensor on the load wire of the VFD for flow status monitoring and alarming.
 2. Monitor flow status via VFD alarm/status contact and frequency feedback signal at the OWS.
 3. Once activated, the designated lead pump shall run continuously. If the lead pump fails, after a 20 second time-delay, the lag pump shall be energized after an alarm is sent to the OWS. After the cause of the failure is corrected, a manual command from the OWS is required to restore normal operation.
 4. The designated lead pump shall be enabled whenever the building heating or cooling system is activated, as programmed through the BAS.
 - a. When the system is manually put in the “winter” mode, the lead pump shall operate through its variable speed drive to provide full flow equal to 60 Hertz on the drive output. The pump speed shall change in response to system pressure changes as described in Paragraph 1.a as terminal unit two-way control valves close off to the system.
 - b. When the system is manually put in the “summer” mode, the lead pump shall operate through its variable speed drive to provide full flow equal to the scheduled chiller evaporator gpm. Coordinate this calibration point during the TAB agenda of the work.
 5. The following items shall be displayed at the OWS:
 - a. Graphical display of pumps and related piping.
 - b. Outside air temperature.
 - c. Designated lead and lag pumps (i.e.: Pump P-A1 Lead - Pump P-A2 Lag).
 - d. Pump command start/stop.
 - e. Commanded status of each pump via VFD alarm/status contact and frequency feedback signal.
 - f. Flow status/alarm via differential pressure switch.

- g. Dual temperature loop discharge and return temperature.
- E. Chilled Water System Control:
 - 1. This system consists of one air-cooled water chiller, CH-A1, dual temperature loop pumps P-A1 and P-A2, and interconnecting piping and accessories. Chiller shall start/stop as programmed by the BAS. Pumps P-A1 and P-A2 shall be controlled directly by the BAS per a lead/lag sequence as described in article D.
 - 2. When the system is scheduled to operate and outdoor air temperature is at or above the programmed setpoint of 60°F, adjustable, system control sequence shall be activated. The system can also be manually activated via a software switch at the OWS. Additionally, the chilled water system activation shall be subject to the summer/winter changeover sequence described under 'Dual Temperature Isolation Valves'.
 - 3. When the chiller control sequence is activated, the lead pump shall be energized. When water flow is proven through each pump, via a current switch, the chiller's factory controller shall be activated to maintain its integral setpoint of 44°F, adjustable.
 - a. Chiller controller shall activate factory installed heat tape on the evaporator whenever chiller is off and outside air temperature is at or below 35°F, adjustable. Verify setting and operation per chiller manufacturer's written instructions.
 - 4. The BAS shall limit the chiller on-time to a minimum of 10 minutes. The minimum off-time for the chiller shall be 20 minutes. Timing set-points are adjustable, and final setting must be approved by the chiller manufacturer.
 - 5. The OWS shall be able to interface all inputs, monitor alarms, and change setpoints.
 - 6. The BAS shall monitor chilled water discharge and return temperatures for display at the OWS.
 - 7. BAS Contractor shall provide all field control wiring for operation of the chiller.
 - 8. The following items shall be displayed at the OWS:
 - a. Graphic depicting equipment, piping layout and temperature control devices with dynamic display of each status, temperature, etc.
 - b. Chilled water discharge and return temperature at the chiller.
 - c. Common chilled water supply and return water temperatures.
 - d. Alarm/status inputs for chiller.
 - e. Chilled water pump start/stop command and status via current switch.
 - f. Chilled water pump flow/alarm per pump via current switch.
 - g. Chiller on/off command and status.
 - h. Heat tape status.
- F. Dual Temperature Isolation Valves
 - 1. Furnish dual temperature isolation valves as shown on the drawings. During heating season, the hot water isolation valves shall be open to the dual temperature piping and the chilled water isolation valves shall be closed. During cooling season, the chilled water isolation valves shall be open and the hot water isolation valves shall be closed. Heating and cooling valves shall be commanded from separate and individual outputs. When switching between heating and cooling, implement an adjustable time delay initially set to 12 hours to allow the dual temperature loop to reach ambient temperature before mixing with primary systems. If any valve does not prove open via end switch, an alarm shall be displayed at OWS.
 - 2. The following items shall be displayed at the OWS:
 - a. Individual zones showing isolation control valves and commanded position.

- b. Operator selection to set heating/cooling position of each isolation control valve of each zone.
- G. Domestic Water Heater System Control
 - 1. The domestic water heaters located in Mechanical Room B122 shall be activated by its integral temperature controls. The heater is equipped with sealed combustion air control which does not require any further control interface. The BAS to provide enable/disable control of heaters based on a time schedule.
 - 2. Provide a hot water discharge sensor for monitoring, high/low limit alarms for the heater and for the hot water circulating loop. The OWS shall receive a general status/failure alarm from the domestic water heater for monitoring and alarm generation at the OWS. Set the high/low limit alarms to suit system operation and water loop.
 - 3. Provide on/off control of the domestic hot water circulating pump based on a schedule furnished by the Owner. Provide a current switch on one phase of power to the pump for monitoring and alarm generation. If the pump is commanded on and flow is not detected, after a 20-second delay, provide an alarm at the OWS.
 - 4. The following items shall be displayed at the OWS:
 - a. Domestic water heater activated/deactivated.
 - b. Domestic hot water discharge temperature.
 - c. High/Low discharge temperature alarm, heater and loop.
 - d. General failure signal.
 - e. Commanded status of domestic hot water circulator pump.
 - f. Pump flow status/failure alarm.
- H. MS Penthouse A301 Heating and Ventilation System Control
 - 1. This system consists of unit heaters UH-A3.1 and UH-A3.2, exhaust fan EF-A5, and an outside air intake. Provide motor operated dampers and actuators for control of exhaust and outside air in the room. Provide space temperature sensor as shown on the drawings.
 - 2. On a rise in space temperature above 80°F, adjustable, the exhaust air and outside air dampers shall open. Subject to a limit switch on the exhaust air damper, the exhaust fan shall start. On a fall in space temperature below setpoint, the fan shall be de-energized and all dampers shall close.
 - 3. On a fall in space temperature below 60°F, adjustable, room sensor shall energize the fan on the unit heater to run and open the hot water control valve. On a rise in space temperature, the reverse shall occur.
 - 4. The following items shall be displayed at the OWS:
 - a. Space temperature.
 - b. Low temperature alarm, 40°F, adjustable.
 - c. High temperature alarm, 100°F, adjustable.
 - d. Heating setpoint.
 - e. Ventilation setpoint.
 - f. Commanded status of exhaust fan and dampers.
 - g. Commanded status of unit heater fan.
 - h. Commanded status of control valve.
- I. Fan Coil Unit Control

1. Each unit shall be controlled by an individual DDC Controller. The DDC Controller shall be provided by ATC and field installed. The DDC Controller shall be wired to a space temperature sensor with setpoint adjustment and override switch (Microtouch). Provide all sensors required for operation, monitoring, and control of each unit; interface with the 24-volt control transformer furnished with the unit. Provide a 2-way control valve for the dual temperature coil for installation by the Mechanical Contractor.
 - a. Provide a flat-plate space sensor for units serving stairways; no override switch is required in these locations.
2. During the programmed occupied mode, the fan shall run continuously. OWS shall be able to override fan from constant operation to cycle fan.
 - a. Provide motor operated dampers and actuators for units which are directly connected to a source of outside air for ventilation. Each damper shall open fully during the occupied mode and remain closed during the unoccupied mode.
 - b. Heating mode: On a fall in space temperature below the programmed heating setpoint of 70°F, adjustable, the coil control valve shall modulate open to the coil. On a rise in space temperature, the valve shall modulate closed. The valve shall be under further control of a high limit discharge air temperature sensor with setpoint at 100°F, adjustable, to prevent damage to the unit's components. Provide an alarm at the OWS if the discharge air temperature rises above the high limit setpoint.
 - c. Cooling mode: On a rise in space temperature above the programmed cooling setpoint of 75°F, adjustable, the coil control valve shall modulate open. On a fall in space temperature, the valve shall modulate closed to the coil.
3. During the programmed unoccupied mode when boiler or chiller is OFF (pending mode of operation). The supply fan shall be de-energized and the control valve closed. During the programmed unoccupied mode when boiler or chiller is ON (pending mode of operation), the supply fan and control valve shall operate as follows: the fan shall cycle and the control valve shall modulate in sequence to maintain the programmed unoccupied space temperature setpoints of 60°F (heating) and 85°F (cooling), all adjustable. When the override switch on the room sensor is activated, the unit shall be controlled as outlined in item 2 above for a minimum 2-hour period, adjustable at the OWS. Once the override cycle times out, the unit shall reset to the unoccupied mode of operation.
4. If the discharge temperature fails to rise to a programmed minimum temperature during a call for heating, a low temperature alarm shall be activated at the OWS. If the discharge temperature fails to fall to a programmed minimum temperature on a call for cooling, a high temperature alarm shall be activated at the OWS.
5. Provide a current switch on one phase of power feeding the supply fan for status indication at the OWS.
6. Provide a condensate sensor in the auxiliary drain pan below each unit. When condensate is detected in the pan, close the coil control valve, deactivate the unit supply fan, and provide an alarm at the OWS.
7. The following items shall be displayed at the OWS:
 - a. Global outside air temperature.
 - b. Space temperature.
 - c. Space temperature setpoint.
 - d. Discharge temperature.
 - e. High and low limit discharge air setpoints.

- f. Commanded status of fan.
- g. Operational status of fan via current switch.
- h. Commanded status of each control valve.
- i. Low discharge temperature alarm.
- j. High discharge temperature alarm.
- k. Condensate alarm.
- l. Commanded status of outside air damper.
- m. Diagram showing the layout of the unit with major components and dynamic temperatures shown where temperature sensors exist in the system.

J.1 Hot Water Cabinet Unit Heater Control

1. Each cabinet unit heater shall be controlled by the BAS via a space temperature sensor.
 - a. Provide a separate DDC controller and flat plate space sensor for each unit; no override switch is required.
 - b. Provide a 2-way, hot water control valve for installation in the unit by the Mechanical Contractor.
2. During the programmed occupied mode, the unit fan shall cycle. On a fall in space temperature below the programmed setpoint of 65°F, adjustable, the hot water coil control valve shall open. On a rise in temperature above setpoint, the valve shall close.
3. During the programmed unoccupied mode when boiler is OFF, the fan shall be de-energized and the control valve closed. During the programmed unoccupied mode when boiler is ON, the fan and control valve shall operate as follows: The fan shall cycle and the hot water control shall open to maintain the programmed temperature setpoint of 60°F, adjustable.
4. If the discharge temperature fails to rise to a programmed minimum temperature during a call for heating, a low temperature alarm shall be activated at the OWS.
5. Provide a current switch on one phase of power feeding the supply fan for status indication at the OWS.
6. The following items shall be displayed at the OWS:
 - a. Space temperature.
 - b. Space temperature setpoint.
 - c. Discharge temperature.
 - d. Commanded status of fan.
 - e. Operational status of fan via current switch.
 - f. Commanded status of control valve.
 - g. Low discharge temperature alarm.
 - h. Diagram showing the layout of the unit with major components and dynamic temperatures shown where temperature sensors exist in the system.

J.2. Hot Water Unit Heater Control

1. Each unit heater shall be controlled by the BAS via a space temperature sensor.
 - a. Provide a separate DDC controller and flat plate space sensor for each unit; no override switch is required.
2. The unit fan shall cycle to maintain the programmed setpoint of 65°F, adjustable.
3. Provide a current switch on one phase of power feeding the unit fan for status indication at the

OWS.

4. The following items shall be displayed at the OWS:
 - a. Space temperature.
 - b. Space temperature setpoint.
 - c. Commanded status of fan.
 - d. Operational status of fan via current switch.
 - e. Commanded status of control valve.

J.3. Zone Hot Water Heating Duct Coil Control

1. Duct coils shall be controlled by an individual DDC Controller and space temperature sensor. Provide space sensor and two-way control valve for each coil.
2. Sensor shall modulate the heating coil control valve to maintain space temperature at 75°F, adjustable.
3. The following items shall be displayed at the OWS:
 - a. Space temperature.
 - b. Space temperature setpoint.
 - c. Discharge air temperature.
 - d. Commanded status of control valve.

K. Ductless Split System Unit Control:

1. The following sequence is typical for all of the systems scheduled on the drawings.
2. Each unit shall be controlled by its factory controls. Adjust factory controls to allow the indoor unit fan to cycle off once space temperature is achieved. Mount and wire the thermostat, which is furnished by the equipment manufacturer, and interlock the controls from the indoor unit to the outdoor unit. Set to maintain 75°F, adjustable. Provide interface to unit provided thermostat for control by Owner.
3. Provide a space mounted temperature sensor for monitoring and alarm generation at the OWS. On a rise in space temperature above the programmed high limit setpoint of 80°F, adjustable, an alarm shall be activated. On a fall in space temperature below the programmed low limit setpoint of 50°F, adjustable, an alarm shall be activated.
4. The following items shall be displayed at the OWS:
 - a. Space temperature.
 - b. High and low limit alarms and setpoints.

L.1 Exhaust Fan Control

1. The sequence that follows is typical for fans EF-A1, A2, and A4. Coordinate occupied/unoccupied scheduling with owner.
2. Provide a motor operated damper and actuator for the exhaust fan as shown on the drawings. The damper shall be installed by the Mechanical Contractor.
3. Exhaust fan shall be energized during the occupied period and de-energized during the unoccupied period via the BAS. The damper shall be open during the occupied mode and shall be closed during the unoccupied mode.
4. Subject to a limit switch on the exhaust air damper, the fan shall run continuously during the occupied mode.
5. Provide a current switch on one phase of power feeding the fan for status indication at the OWS.

6. Interface with a common fire alarm input to the BAS system from the fire alarm system (FAS). When the FAS indicates an alarm condition, the BAS shall de-energize the fan and close the exhaust air damper.
7. The following items shall be displayed at the OWS:
 - a. Fan status via current switch: on/off/alarm.
 - b. Commanded status of fan and damper.

L.2 Exhaust Fan Control: EF-A3 STEM/PLTWA117

1. Exhaust fan shall be energized manually through a switch provided as part of the work of Division 26 – Electric.
2. Provide a motor operated damper and actuator for control of the exhaust air as shown on the drawings.
3. Provide a motor operated damper and actuator for the branch exhaust air duct in each lab as shown on the drawings.
4. Once activated by the switch, and subject to a limit switch on the exhaust air damper, the fan shall run continuously and motor operated damper in the exhaust duct shall open. The exhaust damper in the branch duct shall close. When fan is de-energized, the exhaust fan damper shall close and the branch exhaust damper shall open.
5. Provide a current switch on one phase of power feeding the fan for status indication at the OWS.
6. Interface with a common fire alarm input to the BAS system from the fire alarm system (FAS). Whenever the FAS indicates an alarm condition while the fan is running, the BAS shall deenergize the fan and close the exhaust air damper.
7. The following items shall be displayed at the OWS:
 - a. Fan status via current switch: On/Off/Alarm.
 - b. Commanded status of exhaust fan and damper.
 - c. Commanded status of branch exhaust air duct damper.

M. Energy Recovery Unit Control

1. The following sequence is typical for five units as scheduled on the drawings. Each unit consists of supply fan, exhaust fan, packaged DX cooling system, hot gas reheat for dehumidification, package indirect fired gas heating system, energy recovery wheel and drive, filters, air control dampers and actuators, drives for each fan, and unit controls. Each unit is a constant volume system with 100% outside air and economizer mode of operation.
2. The ERU shall be controlled by an individual DDC Controller. The BAS Contractor shall provide the DDC Controller and all required sensors which shall include, but are not limited to, a discharge air temperature sensor, exhaust air temperature sensor, return air temperature sensor, return air humidity sensor, and global outside air temperature and humidity sensors.
3. The equipment manufacturer shall provide the BAS Contractor with wiring diagrams for the equipment. The BAS Contractor shall then provide wiring diagrams to the equipment manufacturer detailing installation and wiring requirements for the DDC Controls. All ATC work shall be field mounted and wired.
4. The system shall maintain occupied/unoccupied schedule according to its programmed schedule or the reset manually by the BAS. Delay startup of the unit until the zone temperature has recovered from its previous setback or setup temperature during the unoccupied mode. Time schedules shall be coordinated with and approved by owner prior to implementing.

5. Once activated, supply fan, exhaust fan, and energy recovery wheel shall run continuously with the outside air and exhaust air dampers open. The gas fired heating section and DX cooling systems shall be staged in sequence to maintain the minimum return air temperature setpoint of 70°F, adjustable, in the return air duct based on a temperature sensor at the unit return. On a rise in discharge air temperature, the DX cooling system will be staged to provide cooling. On a fall in temperature, the reverse shall occur.
 - a. The supply fan and exhaust fan shall not be energized until the damper is in the open position. Display the end switch position at the OWS. If the end switch does not coincide with the commanded position, provide an alarm at the OWS.
 - b. When the unit is deactivated, the fans, heating and cooling shall be off and all dampers shall be closed.
6. The economizer sequence shall be activated as the first stage of cooling. The DDC controller shall receive input from the global outdoor air temperature sensor. Whenever outdoor air temperature is below 57°F (adj.), the economizer control shall be enabled. On a rise above 62°F (adj.), the economizer control shall be disabled. When activated, the energy wheel shall stop and the economizer bypass damper shall open fully.
7. Whenever outdoor air temperature is below 55 deg. F (adj.), the DX cooling shall be locked out from operating. Whenever outdoor air is above 55 deg. F (adj.), the gas heating shall be locked out from operating.
8. The cooling and hot gas reheat shall be activated to maintain return air humidity. On a rise in return air humidity above the setpoint of 65%, adjustable, the cooling shall be energized at 100% capacity. On a drop in return air temperature below the setpoint of 70 deg. F, adjustable, the hot gas reheat shall be energized to reheat the space. On a rise in return air temperature to the setpoint, the hot gas reheat shall be deactivated. On a fall in return air humidity below the adjustable setpoint, the cooling shall be deactivated.
9. During the unoccupied mode, the supply and exhaust fan shall stop, the energy recovery wheel shall stop, and outside air and exhaust dampers shall close.
10. The DDC controller shall receive input from the unit's factory installed energy wheel rotation sensor for monitoring and alarm generation at the OWS.
 - a. Unit shall continue to run in manual mode until the unit is shut down manually or at the OWS whenever the energy wheel fails.
 - b. Whenever the outside air temperature is +/- 5°F, adjustable, of return air temperature in the unit, the energy recovery wheel shall stop.
11. Interface with a common fire alarm input from the fire alarm system. The fire alarm contact shall be provided at the fire alarm panel by the fire alarm contractor. The status of the alarm contact shall be communicated throughout the BAS. When the fire alarm contact indicates an alarm condition, the BAS shall de-energize the unit. When de-energized, the damper motors shall spring return the outside and exhaust air dampers closed. Provide an alarm at the OWS to indicate fire alarm status. NOTE: the FAS shall also shut down the unit whenever a classroom CO (carbon monoxide) detector goes into alarm.
12. The Mechanical Contractor shall install duct smoke detectors in the supply and return air ducts at the unit as furnished by the FAS vendor as part of the work of Division 26 – Electric. When wired to the fire alarm system as required by the Division 26 contractor, the duct smoke detectors shall alarm the FAS, which shall signal the BAS to de-energize the unit in a manner similar to item 11.
13. Provide a refrigerant leak detector within the ERU at the DX coil. If a leak is detected, the BAS shall de-energize the unit and provide an alarm at the OWS.

14. The following items shall be displayed at the OWS:

- a. Discharge air temperature.
- b. Discharge air temperature setpoint.
- c. Return air temperature.
- d. Return air humidity.
- e. Exhaust air temperature.
- f. Fire alarm system status/alarm.
- g. Supply and exhaust fan start/stop command and speed signal.
- h. Supply fan operational status via a current switch.
- i. Exhaust fan operational status via a current switch.
- j. Energy recovery wheel commanded status, operational status via current sensor and alarm.
- k. Smoke detector status/alarm.
- l. Room CO detector status: Normal/Alarm
- m. Damper command position of all damper actuators.
- n. Global OA temperature and humidity.
- o. Refrigerant leak detector status/alarm.
- p. Diagram showing the layout of the equipment with major components and dynamic temperatures shown where temperature sensors exist in the system.

N.1 Packaged Rooftop Unit Control: General

1. The sequence that follows is typical for RTU-A1 and A3 as scheduled on the drawings. Each unit consists of a supply fan, packaged air-cooled DX cooling system, hot gas reheat for dehumidification, gas fired heating section, air filters, air control dampers and actuators.
 - a. Each unit is a constant volume system with minimum outside air and economizer mode of operation.
 - b. Each unit shall be controlled by an individual DDC Controller. The DDC Controller shall be wired to sensors which shall include, but are not limited to, a discharge air temperature sensor, mixed air temperature sensor, return air temperature sensor, global outside air temperature/humidity/enthalpy, CO2 sensors, and a combination space temperature/humidity sensor. The DDC Controller and all required sensors shall be provided by the BAS Contractor, field mounted and wired.
2. The following items shall be provided by the equipment manufacturer:
 - a. Overload protection.
 - b. Control transformers.
 - c. Dampers and damper motors.
 - d. Terminal blocks for all wiring connections between equipment and control devices.
 - e. Standard factory control modules for unit DX and natural gas functions.

The following items shall be provided by ATC:

- a. Space temperature sensors.
- b. Space humidity sensor or combination space temperature/humidity sensor.
- c. Discharge air temperature sensor.
- d. Return air temperature sensor.

- e. Return air humidity sensor.
 - f. Global outside air temperature and humidity sensors.
 - g. Current sensor for one phase of the power feeding the fan.
 - h. Mixed air average temperature sensor.
 - i. CO2 sensors and space temperature sensors.
 - j. DDC Controller.
3. During the programmed occupied mode, the supply fan shall run continuously with the outside air damper closed. When fan fails to start once activated, initiate an alarm to the system after a twenty second delay. Monitor fan status with a current switch on one leg of power feeding the fan motor. Delay opening the outside air damper to its minimum position until the zone space temperature has recovered from the setback or setup temperature setting. Each fan shall have the ability to cycle on/off with a call for heating or cooling.
- a. Outside air damper shall remain closed until return air CO2 level rises to 700 ppm. The outside air damper shall step open from its minimum position to full scheduled open position to maintain CO2 level at or below 700 ppm. The return air and relief air dampers in the system shall modulate in unison to maintain the balance of air in the system.
 - b. On a continued rise in CO2 level above 900 ppm, activate an alarm at the OWS. On a decrease in CO2 level below 700 ppm, the outside air damper shall step to minimum position.
4. On a drop-in space air temperature below the programmed setpoint of 70°F, adjustable, the unit gas heating section shall be activated and stage to maintain setpoint. Use space sensors to maintain average temperature setting.
5. On a rise in space air temperature above setpoint, the mixing box economizer sequence shall be activated. On a further rise or if the economizer sequence is deactivated, the unit air-cooled DX system shall be activated to maintain setpoint. On a fall in temperature the reverse shall occur. Maintain 75°F, adjustable.
6. The economizer sequence shall be activated as the first stage of cooling. The DDC Controller shall receive input from the global outside air temperature sensor. Whenever outdoor air temperature is below 57°F (adj.), the economizer control shall be enabled. On a rise above 62°F (adj.), the economizer control shall be disabled. The mixing box dampers shall maintain a mixed air temperature of 50°F (adj.).
7. Whenever outdoor air temperature is below 55 deg. F (adj.), the DX cooling shall be locked out from operating. Whenever outdoor air is above 55 deg. F (adj.), the gas heating shall be locked out from operating.
8. On a rise in space humidity level above setpoint, 65% (adj.), the dehumidification sequence shall be activated, whereby the electric heater shall be energized by the BAS or the cooling shall be activated at 100% capacity, while the electric reheat is energized by the BAS. If the unit is already in DX cooling mode, the electric reheat will be energized. On a fall in space humidity below the adjust able setpoint, the dehumidification mode shall be deactivated.
9. During the programmed un-occupied mode, the fan, heating, cooling hot gas reheat, and mixing box dampers shall be cycled/modulated to maintain the un-occupied setpoints of 60°F (heating), 85°F (cooling), and 65% dehumidification, all adjustable. Unless required for economizer cycle, the outside air and relief air dampers shall remain closed with the return air damper fully open.
10. Interface with a common fire alarm input from the fire alarm system. The fire alarm contact shall be provided at the fire alarm panel by the Fire Alarm Contractor. The status of the alarm contact shall be communicated throughout the BAS. When the fire alarm contact indicates an alarm

- condition, the BAS shall de-energize the unit. When de-energized, the damper motors shall spring return the outside and relief air dampers closed. Provide an alarm at the OWS to indicate fire alarm status. NOTE: the FAS shall also shut down the unit whenever the room CO (carbon monoxide) detector goes into alarm.
11. The Mechanical Contractor install duct smoke detectors in the supply and return air ducts at the unit as furnished by the FAS vendor as part of the work of Division 26 – Electric. When wired to the fire alarm system as required by the Division 26 contractor, the duct smoke detectors shall alarm the FAS, which shall signal the BAS to de-energize the unit in a manner similar to item 10.
 12. Provide a refrigerant leak detector within the AHU at the DX coil. If a leak is detected, the BAS shall de-energize the unit and provide an alarm at the OWS.
 13. The following items shall be displayed at the OWS:
 - a. Space temperature and setpoint.
 - b. Space humidity percentage and setpoint.
 - c. Supply air temperature.
 - d. Return air temperature.
 - e. Return air humidity.
 - f. Mixed air temperature.
 - g. Mixed air temperature setpoint.
 - h. Global outside air temperature, humidity and enthalpy.
 - i. Fire alarm system status/alarm.
 - j. Duct smoke detectors status: normal/alarm.
 - k. Commanded status of fan.
 - l. Supply fan operational status via current switch.
 - m. Commanded status of dampers.
 - n. Room CO detector status: normal/alarm.
 - o. Refrigerant leak detector status/alarm.
 - p. Diagram showing the layout of the equipment with major components and dynamic temperatures shown where temperature sensors exist in the system.

N.2 Rooftop Unit Control: RTU-A4/RF-A1

1. The rooftop unit consists of a supply fan, packaged air-cooled DX cooling system, hot gas reheat for dehumidification, gas fired heating section, air filters, air control dampers and actuators with an inline return air fan.
 - a. Unit is a constant volume system with minimum outside air and economizer mode of operation.
 - b. Unit shall be controlled by an individual DDC Controller. The DDC Controller shall be wired to sensors which shall include, but are not limited to, a discharge air temperature sensor, mixed air temperature sensor, return air temperature sensor, global outside air temperature/humidity/enthalpy, CO2 sensors, and a combination space temperature/humidity sensor. The DDC Controller and all required sensors shall be provided by the BAS Contractor, field mounted and wired.
 - c. Interlock unit with its duct mounted return air fan.
2. The following items shall be provided by the equipment manufacturer:
 - a. Overload protection.

- b. Control transformers.
- c. Dampers and damper motors.
- d. Terminal blocks for all wiring connections between equipment and control devices.
- e. Standard factory control modules for unit DX and natural gas functions.
- f. Motor starter and overload protection for the return fan shall be provided as part of the work of Division 26 – Electric.

The following items shall be provided by ATC:

- a. Space temperature sensors.
 - b. Space humidity sensor or combination space temperature/humidity sensor.
 - c. Discharge air temperature sensor.
 - d. Return air temperature sensor.
 - e. Return air humidity sensor.
 - f. Global outside air temperature and humidity sensors.
 - g. Current sensor for one phase of the power feeding the fan.
 - h. Mixed air average temperature sensor.
 - i. CO2 sensors and space temperature sensors.
 - j. DDC Controller.
3. During the programmed occupied mode, the supply and return air fans shall run continuously with the outside air damper closed. When either fan fails to start once activated, initiate an alarm to the system after a twenty second delay. Monitor fans status with a current switch on one leg of power feeding the fan motors. Delay opening the outside air damper to its minimum position until the zone space temperature has recovered from the setback or setup temperature setting. Each fan shall have the ability to cycle on/off with a call for heating or cooling.
 - a. Outside air damper shall remain closed until return air CO2 level rises to 700 ppm. The outside air damper shall step open from it's minimum position to full scheduled open position to maintain CO2 level at or below 700 ppm. The return air and relief air dampers in the system shall modulate in unison to maintain the balance of air in the system.
 - b. On a continued rise in CO2 level above 900 ppm, activate an alarm at the OWS. On a decrease in CO2 level below 700 ppm, the outside air damper shall step to minimum position.
 4. The space temperature reading of the units associated hot water duct coils temperature sensor will be polled and averaged to control RTU's heating/cooling operation. A user selectable checkbox will be located on the OWS to manually remove any room temperature sensor from the polling control logic.
 5. On a drop-in average space temperature below the programmed setpoint of 70°F, adjustable, the unit gas heating section shall be activated and stage to maintain setpoint. Use space sensors to maintain average temperature setting.
 6. On a rise in average space temperature above setpoint, the mixing box economizer sequence shall be activated. On a further rise or if the economizer sequence is deactivated, the unit air-cooled DX system shall be activated to maintain setpoint. On a fall in temperature the reverse shall occur. Maintain 75°F, adjustable.
 7. The economizer sequence shall be activated as the first stage of cooling. The DDC controller shall receive input from the global outside air temperature sensor. Whenever outdoor air temperature is below 57°F (adj.), the economizer control shall be enabled. On a rise above 62°F

- (adj.), the economizer control shall be disabled. The mixing box dampers shall maintain a mixed air temperature of 50°F (adj.).
8. Whenever outdoor air temperature is below 55 deg. F (adj.), the DX cooling shall be locked out from operating. Whenever the outdoor air is above 55 deg. F (adj.), the gas heating shall be locked out from operating.
 9. On a rise in space humidity level above setpoint, 65% (adj.), the dehumidification sequence shall be activated, whereby the electric heater shall be energized by the BAS or the cooling shall be activated at 100% capacity, while the electric reheat is energized by the BAS. If the unit is already in DX cooling mode, the electric reheat will be energized. On a fall in space humidity below the adjust able setpoint, the dehumidification mode shall be deactivated.
 10. During the programmed un-occupied mode, the fans, heating, cooling, hot gas reheat, and mixing box dampers shall be cycled/modulated to maintain the un-occupied setpoints of 60°F (heating), 85°F (cooling), and 65% dehumidification, all adjustable. Unless required for economizer cycle, the outside air and relief air dampers shall remain closed with the return air damper fully open.
 11. Space temperature sensors utilized for unit RTU-A4 control will have their override program enabled. The space temperature sensors contain an unoccupied override button. Pressing the button will initiate a 2-hour (adj.) occupied period. When the period has elapsed, the unit will operate as defined in the above unoccupied mode.
 12. The space temperature sensor TS1 wired to the unit's controller will be used for temperature control if a communication failure occurs with the associated DC-x room temperature sensor.
 13. Interface with a common fire alarm input from the fire alarm system. The fire alarm contact shall be provided at the fire alarm panel by the Fire Alarm Contractor. The status of the alarm contact shall be communicated throughout the BAS. When the fire alarm contact indicates an alarm condition, the BAS shall de-energize the unit and inline return air fan. When de-energized, the damper motors shall spring return the outside and relief air dampers closed. Provide an alarm at the OWS to indicate fire alarm status. NOTE: the FAS shall also shut down the unit whenever the room CO (carbon monoxide) detector goes into alarm.
 14. The Mechanical Contractor install duct smoke detectors in the supply and return air ducts at the unit as furnished by the FAS vendor as part of the work of Division 26 – Electric. When wired to the fire alarm system as required by the Division 26 contractor, the duct smoke detectors shall alarm the FAS, which shall signal the BAS to de-energize the unit in a manner similar to item 13.
 15. Provide a refrigerant leak detector within the AHU at the DX coil. If a leak is detected, the BAS shall de-energize the unit and provide an alarm at the OWS.
 16. The following items shall be displayed at the OWS:
 - a. Space temperature and setpoint.
 - b. Space humidity percentage and setpoint.
 - c. Supply air temperature.
 - d. Return air temperature.
 - e. Return air humidity.
 - f. Mixed air temperature.
 - g. Mixed air temperature setpoint.
 - h. Global outside air temperature, humidity and enthalpy.
 - i. Fire alarm system status/alarm.
 - j. Duct smoke detectors status: normal/alarm.

- k. Commanded status of fan.
 - l. Supply fan operational status via current switch.
 - m. Commanded status of dampers.
 - n. Room CO detector status: normal/alarm.
 - o. Refrigerant leak detector status/alarm.
 - p. Diagram showing the layout of the equipment with major components and dynamic temperatures shown where temperature sensors exist in the system.
- N.3 Rooftop Unit with Energy Recovery Control: RTU-A2.
- 1. This unit is equipped with supply fan, exhaust fan, packaged DX cooling system, hot gas reheat for dehumidification, packaged indirect gas-fired heating section, filters, an energy recovery wheel and drive, filters, air control dampers and actuators, drives for each fan, and unit controls. This unit is a constant volume system with 100% outside air and economizer mode of operation.
 - a. The unit shall be controlled by an individual DDC Controller. The DDC Controller shall be wired to sensors which shall include, but are not limited to, a discharge air temperature sensor, mixed air temperature sensor, return air temperature sensor, global outside air temperature/humidity/enthalpy, and space temperature/humidity sensor. The DDC Controller and all required sensors shall be provided by the BAS Contractor, field mounted and wired.
 - 2. During the unoccupied mode, the unit outside air, relief air damper, and energy wheel bypass dampers shall close (unless unit operates in economizer mode), the energy recovery wheel shall stop, the return air damper shall open, and the fans shall stop. The system shall maintain its scheduled setup or setback temperatures. The BAS system shall activate the rooftop unit supply fan and activate the gas-fired heating section or DX cooling section. Once the zone sensor is satisfied, the unit shall shut down.
 - a. During the programmed un-occupied mode, the supply fan, gas heating, and DX cooling shall be cycled/modulated to maintain the un-occupied setpoints of 60°F (heating) and 85°F (cooling), all adjustable. The outside air, relief air, and bypass dampers shall remain closed (unless unit operates in economizer mode) with the return air damper fully open. The exhaust fan shall remain off.
 - 3. Prior to changeover to the occupied mode, the BAS system shall activate the rooftop unit, start the supply fan, and stage the gas-fired heating section or DX cooling section to restore the zone to heating setpoint of 70 °F, adjustable, or to cooling setpoint of 75°F, adjustable.
 - 4. The outside air damper shall open to its minimum positions, return air and relief air dampers shall open, bypass damper shall close, exhaust fan shall start, and the energy recovery wheel shall start.
 - 5. The Controller shall activate the DX cooling section and gas heating section to maintain space air temperature.
 - a. Whenever the outside air temperature is +/- 5 °F, adjustable, of return air temperature in the unit, the energy recovery wheel shall stop and bypass damper shall open.
 - b. On a drop in space temperature below the programmed setpoint of 70°F, adjustable, the unit gas heating section will be activated to maintain setpoint.
 - c. On a rise in space temperature above setpoint, the mixing box economizer sequence shall be activated as the first stage of cooling. The DDC Controller shall receive input from the global outside air temperature sensor. Whenever outdoor air temperature is below 57°F (adj.), the economizer control shall be enabled. The mixing box dampers shall maintain a mixed air temperature of 50 °F (adj.). On a rise above 62 °F (adj.), the economizer control

shall be disabled and the units DX system will be activated.

- d. Whenever outdoor air temperature is below 55°F, adj., the DX cooling shall be locked out from operating. Whenever outdoor air temperature is above 55°F, adj., the gas heating shall be locked out from operating.
- e. The DDC controller shall receive input from the unit's factory installed energy wheel rotation sensor for monitoring and alarm at the OWS. Unit shall continue to run in manual mode until the unit is shut down manually or at the OWS whenever the energy wheel fails.
6. On a rise in space humidity level above setpoint, 65% (adj.), the dehumidification sequence shall be activated, whereby the dehumidification terminal shall be energized by the BAS or the cooling shall be activated at 100% capacity, while the hot gas reheat is energized by the BAS. If the unit is already in DX cooling mode, the hot gas reheat will be energized. On a fall in space humidity below the adjust able setpoint, the dehumidification mode shall be deactivated.
7. Interface with a common fire alarm input from the fire alarm system. The fire alarm contact shall be provided at the fire alarm panel by the fire alarm contractor. The status of the alarm contact shall be communicated throughout the BAS. When the fire alarm contact indicates an alarm condition, the BAS shall de-energize the unit. When de-energized, the damper motors shall spring all air dampers closed. Provide an alarm at the BAS to indicate fire alarm status. NOTE: the FAS shall also shut down the unit whenever the room CO (carbon monoxide) detector goes into alarm.
8. The Mechanical Contractor shall install duct smoke detectors in the supply and return air ducts at the unit as furnished by the FAS vendor as part of the work of Division 26 – Fire Alarm System. When wired to the fire alarm system as required by the Division 26 contractor, the duct smoke detectors shall alarm the FAS, which shall signal the BAS to de-energize the unit in a manner similar to item 7.
9. Provide a refrigerant leak detector within the AHU at the DX coil. If a leak is detected, the BAS shall de-energize the unit and provide an alarm at the OWS.
10. The following items shall be displayed at the BAS:
 - a. Space temperature and setpoint.
 - b. Space humidity percentage and setpoint.
 - c. Supply air temperature.
 - d. Mixed air temperature.
 - e. Mixed air temperature setpoint.
 - f. Return air temperature
 - g. Return air humidity.
 - h. Exhaust air temperatures
 - i. Fire alarm system status/alarm.
 - j. Commanded status of fans.
 - k. Supply fan operational status via current switch.
 - l. Exhaust fan operational status via current switch.
 - m. Energy recovery wheel commanded status and alarm.
 - n. Smoke detector status/alarm.
 - o. Room CO detector status: Normal/Alarm
 - p. Refrigerant leak detector status/alarm.

- q. Global OA temperature/humidity/enthalpy
 - r. Diagram showing the layout of the equipment with major components and dynamic temperatures shown where temperature sensors exist in the system.
- O. Outdoor Lighting Control:
- 1. Division 26 - Electric shall provide multiple lighting contactors for control of outdoor lighting. The lighting will be divided into two or more zones. The lighting contactors shall be located adjacent to each other as shown on the electrical drawings.
 - 2. Provide an outdoor, ambient light level sensor. During the programmed operation period, the outdoor lighting shall be activated when the outdoor ambient light level falls below the programmed setpoint. Each zone shall have independent light level setpoints and time schedules. Set time schedules and light level setpoints as directed by the owner. All time schedules and setpoints shall be adjustable at the OWS.
 - 3. The following items shall be displayed at the OWS:
 - a. Ambient light level.
 - b. Time schedule per zone.
 - c. Commanded status of each zone.
- P. Biohazard Shut Down System Control:
- 1. Provide a biohazard shutdown system including an emergency shut down switch, a “normal” pilot light and an emergency pilot light. The switch/pilot light assembly shall be located in the Principal’s Office A101M or as directed by the Owner. Provide labeling of all components.
 - 2. When the emergency switch is activated, a signal shall be sent to the BAS to shut down all air handling equipment and to close all outdoor air dampers controlled by the BAS in the entire school. Provide an alarm at the OWS when the switch is activated.
 - 3. The alarm shall be manually reset at the switch and at the OWS before normal system operation resumes.
 - 4. The status of switch/system – normal or alarm shall be displayed at the OWS.
- Q. Blocking Valves
- 1. Furnish blocking valves as shown on the drawings. The purpose of the valves is to prevent chilled water from migrating through the piping to terminal heating only equipment when the system is in the cooling mode, since the equipment is not equipped for condensation. The valves shall be of the two-position type and will fail in the last position (no spring return).
 - 2. For heating only equipment, when the dual temperature loop is in the heating mode, the blocking valves shall be open. When the dual temperature loop is in the cooling mode, the blocking valves shall be closed.
 - 3. An end switch on the valve actuator shall be monitored by the BAS to indicate that the valve is fully open. Provide an alarm at the OWS if the valve is commanded open but not proven open via the end switch.
 - 4. The following items shall be displayed at the OWS:
 - a. Individual blocking valves and commanded position.
 - b. Operator selection to set heating/cooling position of each valve.
 - c. Status of valve end switch/valve open position.
 - d. Alarm if valve is commanded open and end switch does not indicate that the valve is open.
- R. Sump Pump Control:

1. Provide a DDC controller and enclosure.
2. Monitor the sump pump panel status and alarm inputs.

2.11 SEQUENCE OF OPERATION: Field House #1 & #2

A. Building Network Panel

1. The building network control panel shall be located in the Elect. FH106 (FH-#1), and Mech/Elect. FH205 (FH-#2), or as directed by the Owner. Each system shall be capable of remote monitoring from the OWS in Room B125D. Coordinate with the Ethernet link between buildings as provided by Division 26 – Electric.
2. Coordinate required capacity and features to accommodate this project.
3. All control programs and application features shall reside in the building network panel.
4. Provide subsequent levels of control capability to whatever extent necessary to achieve performance required for individual units in their respective local dedicated controllers.
5. Coordinate with the Owner to establish occupied/unoccupied schedules and setpoints. Enter the schedules and setpoints into the system. Provide the required number of input/output points to achieve the specified sequences of operation and monitoring/alarm points.
6. Provide space mounted temperature sensors with guards for monitoring and alarm generation at the OWS. On a fall in space temperature below the programmed low limit setpoint of 50°F, adjustable, an alarm shall be activated.

B. Exhaust Fan Control:

1. Each exhaust fan shall be energized during the occupied period and de-energized during the unoccupied period via the BAS. The damper shall be open during the occupied mode and shall be closed during the unoccupied mode.
 - a. Interlock EF-F1.1 with HV-F1.1.
 - b. Interlock EF-F1.4 with HV-F1.2.
 - c. Interlock EF-F2.1 with HV-F2.1.
2. Provide a motor operated damper and actuator for each exhaust fan as shown on the drawings. The damper shall be installed by the Mechanical Contractor.
3. Subject to a limit switch on the exhaust air damper, the fan shall run continuously during the occupied mode.
4. Provide a current switch on one phase of power feeding the fan for status indication at the OWS
5. The following items shall be displayed at the OWS:
 - a. Fan status via current switch: on/off.
 - b. Commanded status of exhaust air damper: open/closed.

C. Gas Fired Heater/Blower Unit Control

1. Provide a wall mounted temperature sensor and guard as shown on the drawings; interface with factory controls.
2. Unit shall be provided with outside air and return air dampers. Provide actuators for control of the outside air and return air at the unit.
3. During the occupied mode, sensor shall open the outside air damper, return air damper shall be closed, activate unit gas controls, and start unit fan to maintain space temperature at 68°F, adjustable. Unit fan shall continue to run after the gas heat exchanger is de-energized to dissipate heat to a preset temperature. Then the fan shall stop and air damper shall close.
4. During the unoccupied mode, the outside air damper shall be closed and the return air damper at

- the unit shall be open. Sensor shall activate the unit fan and gas heating section to maintain space temperature at 55°F, adjustable.
5. Provide the following indications to the system:
 - a. Space temperature and setpoint.
 - b. Low temperature alarm, 50°F, adjustable.
 - c. Commanded status of unit fan through current switch.
 - d. Commanded status of outside air and return air dampers
- D. Custodial FH104 System Control
1. This system consists of exhaust fan EF-F1.3 and electric unit heater EUH-F1. Provide a motor operated damper and actuator for control of the exhaust air. Provide a space temperature sensor with guard as shown on the drawings.
 2. On a rise in space temperature above 80°F, adjustable, the exhaust air damper shall open. Subject to a limit switch on the exhaust air damper, the exhaust fan shall start. On a fall in space temperature below setpoint, the fan shall be de-energized and the damper shall close.
 3. The following items shall be displayed at the OWS:
 - a. Space temperature.
 - b. Space setpoint.
 - b. High temperature alarm, 100°F, adjustable.
 - c. Low temperature alarm, 50°F, adjustable.
 - d. Commanded status of exhaust fan and damper.
- E. Elect. FH 106 and Mech/Elect. FH205 System Control
1. The following is typical for EF-F1.2 and EF-F2.2. Provide a motor operated damper and actuator for control of the exhaust air. Provide a space temperature sensor with guard as shown on the drawings.
 2. On a rise in space temperature above 80°F, adjustable, the exhaust air damper shall open. Subject to a limit switch on the exhaust air damper, the exhaust fan shall start. On a fall in space temperature below setpoint, the fan shall be de-energized and the damper shall close.
 3. The following items shall be displayed at the OWS:
 - a. Space temperature.
 - b. Space setpoint.
 - b. High temperature alarm, 100°F, adjustable.
 - c. Commanded status of exhaust fan and damper.
- F. Fire Alarm System Interface
1. FAS devices such as fire and smoke detection shall alarm the local FAS panel which shall initiate an alarm condition to the network panel.
 2. All fans shall shut down and all dampers shall close.
- 2.12 SEQUENCE OF OPERATION: Greenhouse/Headhouse Building
- A. Building Network Panel
1. The building network control panel shall be located in the Mech/Elect. AG103, or as directed by the Owner. The system shall be capable of remote monitoring from the OWS in Room B125D. Coordinate with the Ethernet link between buildings as provided by Division 26 – Electric.

2. Coordinate required capacity and features to accommodate this project.
 3. All control programs and application features shall reside in the building network panel.
 4. Provide subsequent levels of control capability to whatever extent necessary to achieve performance required for individual units in their respective local dedicated controllers.
 5. Coordinate with the Owner to establish occupied/unoccupied schedules and setpoints. Enter the schedules and setpoints into the system. Provide the required number of input/output points to achieve the specified sequences of operation and monitoring/alarm points.
 6. Provide a space mounted temperature sensor with guard in the Greenhouse for monitoring and alarm generation at the OWS. On a fall in space temperature below the programmed low limit setpoint of 50°F, adjustable, an alarm shall be activated.
- B. Headhouse HVAC Control
1. This system consists of a gas furnace/blower GF-AG1 and remote condensing unit ACC-AG1.
 - a. Provide a wall mounted temperature sensor with guard as shown on the drawings; interface with factory controls. Wire the sensor to the furnace/blower and condensing unit per manufacturer's instructions.
 - b. Provide a motor operated damper and actuator for control of outside air at the unit as shown on the drawings.
 2. During the occupied mode, the outside air damper shall open, supply fan shall be energized, and unit gas controls or cooling components shall activate in sequence to maintain space temperature at 65°F, adjustable (heating) or 75°F, adjustable (cooling). Unit fan shall continue to run after the gas heat exchanger is de-energized to dissipate heat to a preset temperature. Once space temperature is reached in either mode, the unit fan shall stop and outside air damper shall close.
 3. During the unoccupied mode, the outside air damper shall remain closed. Thermostat shall activate the unit fan and gas heating section to maintain space temperature at 55°F, adjustable. Unit shall remain off in the cooling mode.
 4. Provide the following indications to the system:
 - a. Space temperature and setpoint.
 - b. Low temperature alarm, 50°F, adjustable.
 - c. Commanded status of unit fan through current switch.
 - d. Commanded status of outside air damper.
- C. Electric Wall Heater Control: EWH-AG1 & AG2
1. The heater is furnished with a unit-mounted thermostat.
 2. Set thermostat to maintain 65 °F, adjustable.
 3. Provide control voltage relay for each unit for activation through the OWS based on the owner's occupancy schedule.
 4. Provide space temperature and unit status as indications to the system.
- D. Exhaust Fan Control
1. Provide a motor operated damper and actuator for control of exhaust air.
 2. During the unoccupied mode, damper shall remain closed and fan shall be off.
 3. During the occupied mode specified for the gas furnace unit, damper shall open and fan shall run continuously subject to limit switch on the damper actuator.
 4. The following items shall be displayed at the OWS:

- a. Commanded status of fan.
 - b. Commanded status of damper.
5. Interface with a common fire alarm input to the BAS system from the fire alarm system (FAS). When the fire alarm contact indicates an alarm condition, the BAS shall de-energize the fan and close the damper.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Install system and materials in accordance with manufacturer's instructions and roughing-in drawings, and details and drawings. Install electrical work and use electrical products complying with requirements of these specifications. Mount controllers at convenient locations and heights.
- B. All wiring shall be properly supported and run in a neat and workmanlike manner. All wiring exposed and in equipment rooms shall run parallel to or at right angles to the building structure. All wiring within enclosures shall be neatly bundled and anchored to prevent obstruction to devices and terminals. All wiring shall be in accordance with all local and national codes. Low voltage wiring for space temperature sensors, communication bus between terminal units, etc., above accessible ceilings in finished spaces on the floors may be plenum rated cable. Wiring in all other locations shall be installed in EMT conduit. All electronic wiring shall be #18 AWG minimum THHN and shielded if required, except standard network (Ethernet, LonWorks, etc.) cabling shall be as tested and recommended in lieu of #18 gauge twisted, #22 or #24 gauge is acceptable if used as a part of an engineered structured cabling system. The control manufacturer must submit technical and application documentation demonstrating that this cabling system has been tested and approved for use by the manufacturer of both the control system and the engineered structured cabling system.
- C. Provide all sensing, control, and interlock wiring for the following:
 - System inputs and outputs
 - System communications
 - System power
 - System interlocks
 - Unit controls
- D. The Control Manufacturer shall enter all computer data into the Host computer including all graphics, control programs, initial approved parameters and settings, and English descriptors. The Control Manufacturer shall maintain diskette copies of all data file and application software for reload use in the event of a system crash or memory failure. One copy shall be delivered to the owner during training sessions, and one copy shall be archived in the Control Manufacturer's local software vault.

3.2 DATA CONTROL (D/C) AND GRAPHICS SUMMARY

- A. All hardware, custom software, application software, graphics, etc., necessary to accomplish the control sequences and display the graphics specified shall be provided as part of this contract. Provide all controllers, inputs, outputs, valves, dampers, actuators and flow meters required to provide the control and graphic data described. Provide software setpoints required for display in logical groups and graphics.
- B. Each digital output shall have a software-associated monitored input. Any time the monitored input does not track its associated command output within a programmable time interval, a "command failed" alarm shall be reported.
- C. Where calculated points (such as CFM) are shown, they shall appear in their respective logical groups.
- D. Unless otherwise specified or approved prior to bidding, the primary analog input and the analog

output of each DDC loop shall be resident in a single remote panel containing the DDC algorithm, and shall function independent of any primary or UC communication links. Secondary (reset type) analog inputs may be received from the primary network, but approved default values and/or procedures shall be substituted in the DDC algorithm for this secondary input if network communications fail or if the secondary input becomes erroneous or invalid.

3.3 ACCEPTANCE

- A. The Control Manufacturer shall completely check out, calibrate and test all connected hardware and software to ensure that the system performs in accordance with the approved specifications and sequences of operations approved.
- B. Witnessed acceptance demonstration shall display and demonstrate each type of data entry to show site specific customizing capability; demonstrate parameter changes; execute digital and analog commands; and demonstrate DDC loop stability via trend of inputs and outputs.

3.4 MANUALS

- A. The following manuals will be provided:
 - 1. An Operators Manual shall be provided with graphic explanations of keyboard use for all operator functions specified under Operator Training.
- B. Computerized printouts of all GPC data file including all point processing assignments, physical terminal relationships, scales and offsets, command and alarm limits, etc.
- C. A manual shall be provided including revised as-built documents of all materials required under the paragraph "SUBMITTALS" on this specification.
- D. Two Operators Manuals, and two As-Built Manuals shall be provided to the owner.

3.5 TRAINING

- A. All training shall be by the BMCS contractor and shall utilize operator's manuals and as-built documentation.
- B. Operator training shall include three (3) four-hour sessions encompassing modifying text and graphics, sequence of operation review, selection of all displays and reports, use of all specified OWS functions, troubleshooting of sensors (determining bad sensors), and password assignment and modification. One training session shall be conducted at system completion, one shall be conducted forty-five days after system completion, and one at ninety (90) days, or as requested by the Owner.

3.6 SERVICE GUARANTEE

- A. The control system herein specified shall be free from defects in workmanship and material under normal use and service. After completion of the installation, the control manufacturer shall regulate and adjust all thermostats, control valves, motors and other equipment provided under this contract. If within twelve (12) months from date of acceptance either for beneficial use of final acceptance, whichever is earlier, any of the equipment herein described is proven to be defective in workmanship or materials, it will be replaced or repaired free of charge. The control manufacturer shall, after acceptance, provide any service incidental to the proper performance of the control system under guarantee outlined above for the period of one year. Normal maintenance of the system or adjustments of components is not to be considered part of the guarantee. The control manufacturer will upon completion of the installation, during the warranty period, make available to the Owner, an annual service agreement covering all labor and material required to efficiently maintain the control system.

3.7 FINAL ADJUSTMENT

- A. After completion of installation, adjust thermostats, control valves, motors and similar equipment

provided as work of this section.

- B. Final adjustment shall be performed by specially trained personnel in direct employ of installer of primary temperature control system.

END OF SECTION

SECTION 23 09 50**TESTING & BALANCING OF MECHANICAL SYSTEMS****PART 1 – GENERAL****1.1 JOB CONDITIONS**

- A. Systems shall be completely installed and in continuous operation as required to accomplish the tests.
- B. Heating, ventilating and air conditioning equipment shall be completely installed and in continuous operation as required to accomplish the balance work specified.
- C. Adjust and balance shall be performed when outside conditions approximate design conditions indicated for heating and cooling functions.
- D. Make at least two inspections of the mechanical systems during construction to verify that balancing procedures may be accomplished. Report findings to the Construction Manager.
- E. Balancing firm shall balance Mechanical System two (2) times. The first time shall be considered a rough balance. Any discrepancy in air flow shall be addressed to the Construction Manager. The final balancing will be accomplished after review of rough balance reports.
- F. The final balancing reports shall be submitted and approved prior to project's being considered complete; i.e., commencement of warranties.

1.2 ENGINEER QUALIFICATIONS

- A. The firm shall be an independent organization having no affiliation with construction contractors, equipment sales or design engineering.
- B. The firm shall specialize in balancing heating, ventilating and air conditioning systems.
- C. The firm shall show proof of having balanced and tested at least five projects of similar size and scope.
- D. All field work shall be under the direct supervision of a registered Professional Engineer who is a full-time employee of the balancing firm.
- E. The firm shall be certified by and a member of the AABC (Associated Air Balance Council), or NEBB (National Environmental Balancing Bureau).

1.3 REPORT

- A. Data Sheets:
 - 1. Submit data sheets on each item of testing equipment required.
 - 2. Include name of device, manufacturer's name, model number, latest date of calibration and correction factors.
- B. Report Forms:
 - 1. Submit specimen copies of report forms.
 - 2. Forms shall be 8-1/2 x 11-inch paper for loose-leaf binding, with blanks for listing of the required test ratings and for certification of report.
 - 3. Reports shall be on standard forms published by AABC or NEBB.

PART 2 – PRODUCTS**2.1 AIR BALANCE INSTRUMENTS**

- A. Alnor Velometer with probes and alnor pitot tube.
- B. Rotating Vane Anemometer: 4-inch size.
- C. ASHRAE Standard Pitot Tubes, stainless steel 5/16 inch outside diameter, lengths 18 inches and 36 inches.

- D. Magnehelic Differential Air Pressure Gauges, 0 to 0.5 inches, 0 to 1.0 inch and 0 to 5.0 inches water pressure ranges, each arranged as a portable unit for use with a standard Pitot tube.
- E. Combination Inclined-Vertical Portable Manometer, range 0 to 5.0 inches water.

2.2 WATER BALANCING INSTRUMENTS

- A. 30 Inch Mercury U-Tube Manometer, 200 psig, with 3 valve bypass assembly and return wells or mercury check valves.
- B. Inspector's gauge testing set.
- C. Water Differential Pressure Gauge, 4-1/2-inch dial, 0 to 100 psi range.
- D. Pressure gauge measurement points, quick connect couplings, 1/4-inch psi.

2.3 SYSTEM PERFORMANCE MEASURING INSTRUMENTS

- A. Insertion Thermometers, with graduation at 0.5 degrees F for air and 0.1 degrees F for water.
- B. Sling Psychrometer.

PART 3 – EXECUTION

3.1 GENERAL REQUIREMENTS

- A. Arrange and pay for all tests.
- B. Notify Construction Manager at least three working days in advance of test and conduct in presence of Construction Manager.
- C. Tests to be performed prior to insulation, covering or concealment.
- D. Provide signed report of completion of test with signature of witnesses. Report shall indicate:
 - 1. System Tested
 - 2. Date
 - 3. Specified test requirements and actual testing results
- E. The balancing firm shall report to and review the work required with the Architect/Engineer before beginning field balance work. The balancing firm shall make at least two inspections of the air systems during construction and shall report his findings in writing to the Architect/Engineer.
- F. The balancing firm shall indicate in their preliminary report any deficiencies preventing them from performing a proper balance. Report shall be turned over to CM and MC to have items corrected.
- G. The balancing firm shall cooperate with the Construction Manager and the Mechanical Contractor to effect smooth coordination of the balancing work with the job schedule.
- H. The balancing firm shall be responsible for getting the various systems into proper operation. They shall enlist the aid of the equipment suppliers and Mechanical Contractor as may be required to effect proper operation consistent with the contract plans and specifications.
- I. When the balancing firm cannot balance a belt-driven piece of equipment with the supplied belts and sheaves, inform the Mechanical Contractor that the Mechanical Contractor shall provide additional sheaves as spelled out in other Division 23 Sections.

3.2 CIRCULATING WATER SYSTEM TEST

- A. All piping tests shall be applied not only to piping, but also to all devices and equipment connected thereto with the exception of control valves, boilers or any other equipment which may be damaged by the test pressure. All valves shall be full open.
- B. Test at 100 psi hydrostatic pressure for 6 hours:
 - 1. Record pressures each hour
 - 2. Repair all leaks

3. Retest until 6 hours can be completed with no leaks or loss of pressure.
- C. After completion of successful test, strainers shall be cleaned, then system shall be backflushed and strainers cleaned again.
- 3.3 DUCTWORK TESTING
 - A. Witness testing conducted by the Mechanical Contractor per Section 230600, PART 3: EXECUTION.
- 3.4 BALANCING PROCEDURE
 - A. Air System Balance:
 1. With the fan supply system set to handle normal minimum outdoor air, the balancing firm shall perform the following tests and compile the following information:
Air Handling Equipment
 - a. Design Conditions:
 - (1) CFM Supply Air
 - (2) Static Pressure
 - (3) CFM Fresh Air
 - (4) Fan RPM
 - b. Installed Equipment:
 - (1) Manufacturer
 - (2) Size/Model Number
 - (3) Motor HP, Voltage, Phase, Full Load Amperes
 - c. Field Test:
 - (1) Fan Speed
 - (2) No Load Operating Amperes
 - (3) Fan Motor Operating Amperes
 - (4) Calculated BHP
 - d. Test for Total Air:
 - (1) Size of discharge, return air and outside air ducts.
 - (2) Number and locations of Velocity Readings taken.
 - (3) Duct Average Velocity
 - (4) Total CFM
 - (5) Outside Air CFM
 - (6) Return Air CFM
 - e. Individual Outlets (Diffusers, Registers and/or Grilles):
 - (1) Identify each outlet or inlet as to location and area and fan system
 - (2) Outlet, manufacture and type
 - (3) Outlet size
 - (4) Outlet free area, core area, or neck area
 - (5) Required FPM and test velocity found for each outlet.
 - (6) Required CFM and test results for each outlet

2. After completion of tests, adjustment and balancing under minimum fresh air conditions, set the system for 100% fresh air. Repeat the total CFM tests to check field versus design conditions. The results under 100% fresh air cycle shall agree with conditions found under "minimum fresh air operation" before the system is considered to be in balance. Adjustments of the proper dampers shall be made to achieve balance.
 3. Testing and adjusting of individual outlets shall be performed under procedures recommended by the manufacturers of the outlets. All outlets shall be set for air pattern required and all main supply air and return air dampers to be adjusted and set for design CFM indicated. Any required changes in air patterns, settings, etc., necessary for achieving correct air balance, shall be provided by this Contractor. Total CFM of all outlets shall agree with total CFM of all branches and the grand total shall agree with the air volume for the fan(s).
- B. Water Balance:
1. Water balance shall include dual temperature water, heating water, chilled water and condenser water systems. The balancing agency shall perform the following tests, compile data and submit reports.
 2. Pumps:
 - a. Design Data
 - (1) GPM, head
 - (2) RPM, BHP
 - b. Installed Equipment
 - (1) Manufacturer, Size
 - (2) Type Drive
 - (3) Motor HP, Volts, Cycles and Phase
 - (4) Full Load Amperes
 - c. Field Test
 - (1) Discharge Pressures: Full flow & no flow
 - (2) Suction Pressures: Full flow & no flow
 - (3) Operating Head and GPM
 - (4) No Load Amperes (where possible)
 - (5) Full Flow Amperes, No Flow Amperes
 - (6) Calculated BHP
 3. Heating and/or Cooling Elements Including Loop Water to all terminal Units:
 - a. Design Data:
 - (1) MBH Specified, GPM Specified
 - (2) Entering Water Temperature (EWT)
 - (3) Entering Air Temperature (EAT)
 - (4) Water Temperature Drop (DTW)
 - (5) Element Type Specified
 - b. Field Test:
 - (1) Identify each element as to location
 - (2) Required water temperature drop corrected for item (3) above

(3) Actual entering air and water conditions (temperature and GPM)

(4) Adjust element until required temperature drop is obtained

- C. In addition to the above work, the Balancing Firm shall check the operation of all automatic temperature control equipment; verify all thermostat, aquastat, etc., set-points and operations; and enlist the aid of the Mechanical Contractor and the Control Subcontractor to make necessary adjustments where required.

END OF SECTION

SECTION 26 00 00
GENERAL PROVISIONS – ELECTRICAL

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary and other conditions, if any) and Division 1 as appropriate, apply to the work of this Section.
- B. The specification or drawing and the design features or resulting construction disclosed, are the property of Furlow Associates, Inc., and shall not be reproduced without written permission.
- C. Refer to Section 078413 for Through-Penetration Firestop Systems.
- D. Refer to Section 083113 for Access Doors and Frames

1.2 DESCRIPTION OF WORK

- A. Provide all materials, equipment, labor, services and all appurtenances required to completely install and satisfactorily operate the various systems. The items listed below are for general guidance only and do not necessarily include the entire requirements for the project.
 - 1. Coordination with other trades
 - 2. Electrical service
 - 3. Interior feeders
 - 4. Lighting and power panels
 - 5. Lighting branch wiring
 - 6. Power wiring
 - 7. Lighting fixtures and lamps
 - 8. Wiring devices
 - 9. Connections for electrically operated equipment
 - 10. Fire alarm and detection system
 - 11. Telephone/Data systems
 - 12. Lightning protection system
 - 13. Related work as herein described or otherwise defined under the heading "Related Work".
- B. Wherever the term "provide" is used, it shall be understood to mean both "furnish" and "install".

1.3 RELATED WORK

- A. Equipment specified in sections of Divisions 1 thru 23 that require electric power supply.
- B. Work related to this trade as defined on the following contract drawings:

Architectural/Structural

HVAC

Plumbing

1.4 SITE CONDITIONS

- A. Attention of all bidders is called to the necessity for a careful inspection of the site, its present condition and encumbrances, the extent of the work, the protection to be afforded to adjacent properties or structure, availability of utilities, the extent and nature of the material required to be excavated and the amount of fill and removal. He shall also determine local or site limitations which will affect construction.

1.5 PERMITS, INSPECTIONS AND ORDINANCES

- A. All work shall be executed and inspected in accordance with local and state ordinances, rules and regulations and the requirements of public utilities having jurisdiction. The contractor shall secure and pay for all permits, inspections and connections required.
- B. The Electrical Contractor shall furnish a certificate of inspection to the Owner at the time of completion.
- C. Requirements of the following organization shall be considered minimum:
 - 1. National Electrical Code
 - 2. National Electrical Safety Code
 - 3. OSHA
 - 4. Local City and County Codes
- D. Reference to technical societies, trade organizations and governmental agencies are in accordance with the following:
 - 1. ANSI - American National Standards Institute
 - 2. ASTM - American Society for Testing Materials
 - 3. IEEE - Institute of Electrical and Electronics Engineers, Inc.
 - 4. NEC - National Electrical Code
 - 5. NEMA - National Electrical Manufacturer's Association
 - 6. NFPA - National Fire Protection Association
 - 7. MSS - Manufacturer's Standardization Society
 - 8. IES - Illuminating Engineers Society
 - 9. ETL - Engineering Testing Laboratories
 - 10. EIA - Electronic Industries Association
 - 11. OSHA - Occupational Safety and Health Administration
 - 12. Federal Specifications
 - 13. UL - Underwriters Laboratories, Inc.

1.6 QUALITY ASSURANCE

- A. Provide adequate supervision of labor force to assure that all aspects of the contract documents are fulfilled.
- B. Contractor to provide manufacturer's written certification that the following equipment has been installed and will operate correctly and in accordance with the manufacturer's warranty requirements.
Fire Alarm and Detection System
- C. Testing:
 - 1. After completion of the work, the entire wiring system shall test entirely free from grounds, short circuits, opens, overloads and improper voltage.
 - 2. The grounding system shall be tested for a resistance of 25 ohms or less.
 - 3. Perform testing as follows: Arrange and pay for all tests, provide all equipment, materials and labor to perform test. Notify Engineer and Owner three (3) working days before tests are to be made. Conduct tests in the presence of the Engineer or authorized representative. Repeat tests after defects are corrected.
- D. Special Engineering Services: In the instance of complex specialized electrical power and signaling

systems, and other similar systems, the installation and final connections of these systems shall be made by and/or under the supervision of a competent installation and service engineer who shall be a representative of the respective equipment manufacturer. Any and all expenses of these installation and service engineers shall be borne by this Contractor.

1.7 COORDINATION

- A. As a requirement of this project, the Electrical Contractor shall furnish coordination for his equipment and layouts with other subcontractors furnishing equipment and services for Divisions 1 thru 23. Any and all contractors who install their equipment or furnish services prior to coordination, any contractor who changes their equipment or services after coordination has occurred, without notifying associated subcontractors, shall be held responsible for making all required changes with no additional cost to the Owner. Or delay in construction time. This coordination will include conduit layout to allow access to equipment for maintenance.
- B. The Mechanical, Plumbing and Electrical Contractors are responsible to coordinate all manufacturer's recommended circuit breakers, starters, disconnects and fuse sizes for all equipment. Submission of a shop drawing will certify that this has been completed.
- C. The drawings and specifications reflect the type, number and size of services required for the equipment the design is based upon. Should the supplying subcontractor elect to furnish an alternate piece of equipment requiring difference services and/or space conditions, he shall inform the subcontractor furnishing those services and be held responsible to pay for all required changes as part of this contract.

1.8 SUBMITTALS

- A. Shop Drawings:
 - 1. Shop drawings shall be submitted in accordance with Division 1 of these specifications except where herein modified.

NOTE: Submittals will only be reviewed once and resubmittals will be reviewed once. Any other submittals will be billed to the Contractor at the Engineer's standard rates.

- 2. Shop drawings comprising complete catalog cuts, performance test data for electrical equipment as required by other sections of Division 26 shall be submitted for review checking. The Contractor shall review these shop drawings for conformance to contract documents prior to submission and affix contractor's signature to each submittal certifying that this review has been done. By approving and submitting shop drawings, product data, wiring diagrams and similar materials, the Electrical Contractor represents that he and/or his subcontractor has determined and verified materials, field measurements and field construction data that relates to the work, and has checked and coordinated this information with all of the Divisions 1 thru 23 subcontractors.
- 3. All shop drawing submittals shall have the following identification data, as applicable, contained therein or permanently adhered thereto:
 - a. Project name
 - b. Project number
 - c. Sub-Contractor's, Vendor's and/or manufacturer's name and address.
 - d. Product identification.
 - e. Identification of deviation from the contract documents.
 - f. Applicable contract drawings and specification section number.
 - g. Shop drawing title, drawing number, revision number, and date of drawing and revision.
 - h. Resubmit revised or additional shop drawings as requested.

- i. Wherever shop drawings or vendor's standard data sheets indicate work to be done "by others", it shall be the responsibility of the Contractor making the submission to identify by name, the Contractor who is to do this work. If the Contractor named is other than the Contractor making the submission, the shop drawing submission must be reviewed by the named Contractor and bear his mark of approval, prior to submission to the Architect/Engineer.
- j. Where equipment proposed differs from that shown on the drawings or specified, he shall submit for approval drawings showing the manner in which the layout is affected by the substitution.
- k. The Contractor shall keep one copy of approved shop drawings at the job site, filed in a suitable metal container. The shop drawings shall be cataloged and kept in good repair, and shall be available for use by the Owner, Architect and Engineer.
- l. No equipment shall be ordered, fabricated, etc., before approval of shop drawings.

1.9 SUBSTITUTIONS

- A. Whenever a material, article, piece of equipment or system is identified in the following specification or indicated on the drawings by reference to manufacturers' or vendors' names, trade names, catalog numbers or the like, it is so identified for the purpose of establishing the basis of the Bid.
- B. Substitution approval must be obtained and included as an addendum item prior to the submission of the bid. An approved substitution shall not be considered as an approval for the contractor or an equipment vendor to deviate from the written portion of the specifications unless so stated in the addendum.
- C. The drawings illustrate the space allocated for equipment and the Contractor shall install the equipment accordingly. If changes are required in the building or arrangement due to substitution of equipment, the Contractor making the substitution must pay for the necessary modifications.
- D. The listed equivalent or substituted manufacturers along with the bidding related contractor shall be completely responsible to comply with all requirements on all contract documents. This shall include, but shall not be limited to space requirements, code clearances, the type, horsepower, capacities, number and size of services required from other trades, including all required ancillary items furnished and installed by other trades. If the manufacturer or related bidding contractor does not comply with these requirements, then they shall be responsible for any and all additional costs associated with the changes required by other trades.

1.10 LUBRICATION

- A. Furnish, install and maintain all required lubrication of any equipment operated prior to acceptance by the Owner. Lubrication shall be as recommended by the equipment manufacturer.
- B. Provide one year's supply of lubricants to Owner at date of acceptance.
- C. Verify that required lubrication has taken place prior to any equipment start-up.

1.11 ADJUSTMENT & CLEANING

- A. Adjust and clean equipment to be placed in proper operation condition.

1.12 EQUIPMENT START-UP

- A. Verify proper installation by manufacturer or his representative.
- B. Advise General Contractor 2 days prior to actual start-up.
- C. Verify proper operation. Obtain signed statement by manufacturer or his representative that equipment is operating within warranty requirements. Submit statement to General Contractor.

1.13 OPERATION AND MAINTENANCE INSTRUCTIONS

- A. Properly and fully instruct Owner's personnel in the operation and maintenance of all systems and equipment.
- B. Insure that the Owner's personnel are familiar with all operations to carry on required activities.
- C. Such instruction shall be for each item of equipment and each system as a whole.
- D. Provide report that instruction has taken place. Include in the report the equipment and/or systems instructed, date, contractor, Owner's personnel, vendor, and that a complete operating and maintenance manual has been reviewed.
- E. Manual shall include all instructions on operation, maintenance, repair parts list, lubrication requirements, brochures, catalogue cuts, wiring diagrams, piping diagrams, control sequences, service requirements, names and addresses of vendors, suppliers and emergency contacts. Three manuals shall be provided.
- F. Submit manuals for review prior to operating instruction period. Manuals shall be 8-1/2 x 11" with hard cover, suitably bound.
- G. Training
 - 1. Electrical Contractor shall be responsible for coordination of Owner training. Factory employed technician(s) shall provide training, including demonstration and education on the system capabilities, operation and maintenance. Training sessions shall be minimum 4 hours (maximum 8 hours), and shall be provided for each shift of workers. Scheduled training shall be coordinated at least two (2) weeks in advance with the Owner and the Commissioning Agent.
 - 2. Video Documentation: Furnish three (3) copies of a professionally taped video and three (3) copies of professionally prepared drawings demonstrating the following:
 - Emergency Generator System
 - Security System
 - Fire Alarm System
 - Integrated Access Control
 - Clock and Speaker System
 - VFD's
 - MDF/IDF

1.14 TOOLS

- A. All equipment furnished by the Contractor which requires special tools or devices other than those normally available to the maintenance or operating staff shall be furnished in duplicate to the Owner, sufficiently marked, packed or boxed for staff usage. The tools provided shall be listed by the Contractor identified as to their use or the equipment applicable in a written transmittal to the Owner.

1.15 CLEANING AND FINISHING

- A. After equipment start-up and all operating tests have been made and the system pronounced satisfactory, each respective Contractor shall go over the entire project, clean all equipment, etc., installed by him and leave in a clean and working condition. Any surfaces found marred after this final cleaning shall be refinished or replaced by each Contractor at no cost to the Owner.

1.16 OPERATING AND MAINTENANCE MANUALS

- A. Three complete sets of instructions containing the manufacturer's operating and maintenance instructions for each piece of equipment shall be furnished to the Architect. Each set shall be furnished before the contract is completed. The following identification shall be inscribed on the covers: the words "OPERATING AND MAINTENANCE INSTRUCTIONS", the name and location of the building, the name of the Contractor and the name of the Architect and Engineer.

Flysheet shall be placed before instructions covering each subject. The instruction sheets shall be approximately 8-1/2 by 11 inches, with large sheets of drawings folded in. The instructions shall include, but shall not be limited to, the following:

Approved wiring and control diagrams, with data to explain the detailed operation and control of each component.

A control sequence describing start-up, operation and shutdown.

Operating and maintenance instructions for each piece of equipment, including lubrication instructions.

Manufacturer's bulletins, cuts and descriptive data.

Parts lists and recommended spare parts.

1.17 SERVICE INTERRUPTION

- A. All service interruptions to the electric or related systems, whether during regular working hours or at any other time, must be coordinated with the Owner. All such interruptions shall be so scheduled and planned as to require a minimum of time and shall occur only during a mutually satisfactory period.

1.18 INTERPRETATION OF SYSTEMS

- A. The interpretation of the Architect will be final in the event there is a lack of understanding of the full scope or requirements of the systems under this contract.

1.19 LAYOUTS

- A. On small scale drawings, i.e., 1/8" - 1'-0", the approximate location of the electrical branch circuit items such as receptacle, telephone, grounding and equipment outlets are shown to indicate their existence. The exact location of these items and their related raceways are governed by structural conditions, coordination with the work of other trades and the Architect's final decision. By accepting a contract, the Contractor agrees to install the work in accordance with the above statement and within the contract price.

PART 2 – PRODUCTS

2.1 MATERIAL

- A. All material shall be new and of good quality. Material shall conform to all accepted trade standards, codes, ordinances, regulations, or requirements governing same, and shall be approved before being installed.
- B. The Architect reserves the right to require the Contractors to submit samples of any or all articles or materials to be used on the project.
- C. Where any device or equipment is herein referred to in the singular number, such as "the panel", this reference shall be deemed to apply to as many such devices or equipment as are required to complete the installation as shown on the drawings or specified.
- D. All materials and equipment used in the work shall comply with the standards of recognized authorities such as UL, NEMA, IEEE, ETL, IES and EIA in every instance where such standards have been established for the particular type of materials to be installed.
- E. All similar pieces of equipment or materials of the same type or classification used for the same purpose shall be of the same manufacturer.
- F. All manufactured equipment shall have factory applied finishes.

2.2 CONCRETE

- A. Concrete shall be in accordance with Section 03300.

- B. The 28-day minimum compressive strength shall be 3000 psi.

2.3 WARRANTY

- A. Wherever in the specification sections of this division, reference is made to a specific warranty period, this warranty shall be in addition to and not a limitation of other rights the Owner may have against the Contractor under the contract documents.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Prior to performing the work, examine areas and conditions; check and verify all dimensions, under which the work is to be installed and notify the Architect in writing of conditions and dimensions detrimental to the proper and timely completion of the work. Do not proceed until authorization is given by the Architect.

3.2 LAYING OUT WORK

- A. The Contractor is responsible for the accuracy of all lines, elevations, and measurements, grading and utilities and must exercise proper precaution to verify figures shown on drawings before laying out work and will be held responsible for any error resulting from his failure to exercise such precaution.

3.3 WORKMANSHIP

- A. Install all work neat, trim, parallel and plumb with building lines in accordance with standard trade practice acceptable to the Architect.

3.4 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Protect all equipment and materials from damage during transportation, storage and installation.

3.5 PROTECTION

- A. Protect all work, equipment and materials during construction up to the time of acceptance by the Owner.

Arrange and design the protection to prevent damage from infiltration or dust, debris, moisture, chemicals and water. Cap or plug electrical raceways.

- B. Protect all surfaces against damage from welding, cutting, burning, or similar construction functions. This protection shall be accomplished by care in operations, covering and shielding. Special care is directed to exposed finished masonry, metal or wood surfaces and painted surfaces. Corrective measures required shall be accomplished by the trade which made the original installation when and as directed by the Architect at the expense of the Contractor.

- C. Cover and protect all lighting fixtures as may be necessary until completion of the work. Replace damaged fixtures or damaged fixture parts as directed by the Architect at no cost to the Owner.

- D. Do not install devices, polished metal fittings or parts until adjoining tile or masonry work is completed.

- E. Maintain and replace protective covering when so directed by the Architect until the work is ready for acceptance.

3.6 CUTTING & PATCHING

- A. Furnish information to the General Contractor as to sizes and locations of recesses required to install panel boxes and other equipment or devices. If the information is late or incorrect, this Contractor shall, at his own expense, have the trade which originally installed the work do the required cutting and patching.

- B. Perform all cutting of concrete or other material for passage of raceways as required to install the work.

- C. Close all such openings around raceways with material as specified under the heading "SEALING".

- D. Install concealed work in place for the mason to wall-in as he carries up the walls; otherwise, this Contractor will be responsible as stated in the first paragraph.

3.7 SEALING

- A. Where raceways pass through fire-rated walls and floors, seal opening with RTV foam.
- B. Seal raceways entering the building to conform to the requirements of the NEC.

3.8 OFFSETS AND MODIFICATIONS

- A. Furnish and install all offsets necessary to install the work and to provide clearance for the work of other trades.
- B. Maintain adequate clearance as directed by the Architect/Engineer.
- C. Incidental modifications necessary to the installation shall be made as necessary and at the direction and/or approval of the Architect.

3.9 SLEEVES

- A. Furnish and install sleeves for all raceways passing through floors and walls. Sleeves shall be Schedule 40 galvanized steel pipe and shall extend 1" above finished floor surface. Where sleeves are set in interior walls, they shall finish flush with the wall.
- B. Furnish and install watertight sleeves for all raceways extending through foundation walls into crawl spaces, mechanical rooms or basement areas from building exterior or from unexcavated areas to building interior. Sleeve shall consist of extra heavy pipe sleeve with anchor flange. Space between raceway and the sleeve shall be sealed with modular wall and casing seal similar to Thunderline Corporation "Link-Seal", Metraseal or approved substitute. Install seal in strict accordance with the manufacturer's recommendations.

3.10 EXCAVATION

- A. The excavation shall be of the open-trench method and to the depths and widths as may be necessary. The Contractor shall do all excavation required in connection with his work. Bottoms of trenches shall be excavated to a uniform grade. All materials excavated shall be deposited on the side of the trenches and beyond the reach of slides. Excavated material shall not be piled where it will interfere with traffic.
- B. No conduits shall be bedded directly on rock. They shall be cushioned by a 6-inch layer of crushed stone or gravel of selected grade, of size to pass through a 3/4" mesh sieve. Not less than 30% shall be fine which will pass through a 3/8" mesh sieve.
- C. Where excavation is required through tree root areas, roots shall be saw cut, treated with pruning paint and covered with burlap. Burlap shall be wet and shall be protected and maintained in a moist condition during entire period of exposure. Backfill shall be carefully placed and hand-tamped to a minimum of 6" above roots.
- D. Bidder shall base his estimate upon the presumption that all excavation required in the performance of this Contract will be earth. If rock is encountered, Contractor will be reimbursed for the additional work required to remove same based upon the unit cost established in the proposal.
- E. All detached boulders or loose stone not exceeding 1 cubic yard, all topsoil, sand, gravel, clay, rubbish, walls or other subgrade construction, and all other materials of every name and nature which can be removed without breaking up with pneumatic breakers shall be considered earth excavation.
- F. All rocks, attached boulders, boulders exceeding 1 cubic yard, walls or other subgrade construction and materials which cannot be removed without breaking up with pneumatic equipment shall be considered rock excavation.

- G. Before commencing any rock excavation for which extra compensation is to be paid, a rock contour drawing shall be prepared by the Contractor and checked by the Architect. The width shall be based on 2'-0". This rock contour drawing and width allowance will be used to compute the quantity of rock for which the Contractor will be reimbursed at the unit price established.

3.11 SHORING AND PUMPING

- A. The Contractor shall provide all shoring, bracing or sheet piling necessary to maintain the banks of his excavation and shall take out same as the work progresses and filling in has been accomplished. Shoring shall be in accordance with OSHA Standards.
- B. The arrangement of shoring must be such as to prevent any movement of the trench banks and consequent strains on the conduits. Shoring shall be provided to prevent damage to work installed by other trades.
- C. The Contractor shall do all pumping required to keep his excavations free of water. The water shall be conveyed in piping or watertight troughs a sufficient distance that it will flow from the site and not affect other work being performed.

3.12 BACKFILLING

- A. After work in trenches has been completed, they shall be filled with good, clean, fine earth in 8" layers and shall be pneumatically tamped before the next layer of material has been filled in. The backfill shall be free of excavated rock, cinders, stones, brickbats or other debris.
- B. Wherever rock is removed, the Contractor shall secure and fill select clean earth to a minimum depth of 3'-0" above the top of the conduit. Unless otherwise indicated, no rock shall be deposited in the trench fill. This clean earth fill shall be procured other than from the site unless permission for earth borrow from the site is granted by the Architect. If site borrow is permitted, the topsoil removal, relocation and finished grading will be accomplished as directed by the Architect.
- C. Under no circumstances shall excavated material be left where it will interfere with the Owner's or other Contractor's operations.
- D. All earth and other materials taken from the trenches and not required for backfilling shall be deposited where directed, or removed from the premises as directed by the Architect.
- E. Any rock removed from the excavation shall be removed from the project site by the Contractor.
- F. Trenches which pass under wall footings or within 18" of column footings shall be backfilled with clean concrete. To secure adequate foundation support, the method and depositing of the concrete fill shall be as directed by the Architect. To prevent the concrete from adhering to the conduits, necessary conduit protection shall be applied.

3.13 FOUNDATIONS FOR EQUIPMENT/HOUSEKEEPING PADS

- A. Provide all foundations for equipment installed under this specification Division and/or as indicated on plans.
- B. Construct concrete foundations on structural floor slabs or on grade in the manner or as required by the approved shop drawing details of the manufacturer or the utility company.
- C. Provide and install concrete.
- D. Metal reinforcement shall be deformed steel bars or cold drawn steel wire, or fabricated forms of these materials as required.
- E. Furnish anchors of size and number noted, with bottom plates and sleeves.
- F. Forms shall conform to the shape, lines, grades, and dimensions of the concrete, required by the approved shop drawing details of the equipment manufacturers, or approved on the Contractor's Equipment room layouts. They shall be sufficiently tight to prevent leakage of mortar and shall be braced or tied together to maintain position and shape. Forms shall be moved in such manner as to

insure the complete safety of the structure.

- G. All exposed corners or edges shall be chamfered. All burrs, fins, irregularities of forming or spillage shall be removed and the surface float or trowel finished to a smooth, straight surface.
- H. Housekeeping Pads: Provide 4" thick, and size as required by approved shop drawings, concrete pad for all equipment installed on floor. Pad shall be steel reinforced with all edges and surfaces finished as described above. When installing over existing concrete, surface of existing pad shall be prepped using a bushing tool to rough in entire surface. Whether pouring over new or existing concrete, provide U-shaped rebar anchors set in epoxy to secure pad to pad.

3.14 ITEMS RECESSED IN MASONRY CONSTRUCTION

- A. Wherever boxes, electric panels, equipment, devices, access panels, and similar items of electrical construction are installed in exposed masonry construction, the Contractor shall utilize and submit for approval items of such size, height, and arrangement to conform to the corresponding masonry unit. The Contractor shall include as part of this contract, the necessary offsets, adjustments and relocations necessary to conform with the instructions of the Architect as to the final location of the equipment item in the exposed masonry.
- B. As part of his contract and before the purchase of the items hereinbefore mentioned, the Contractor shall notify the Architect of such modifications in the building arrangement that will be necessary to accommodate the proposed equipment.

3.15 ROOF FLASHINGS

- A. All conduit extending through roofs shall be provided with watertight flashing and counterflashing as hereinafter described.
- B. Furnish and install standard counterflashing fittings on the conduit or properly designed clamped counterflashing with caulking as directed by the Architect/Engineer.

3.16 PAINTING

- A. Refinish all factory applied finishes that have been damaged to match the original finish as directed by the Architect.
- B. Prime coat all steel furnished under this Division with material and methods as described in another Section under the heading "PAINTING".

3.17 EQUIPMENT CONNECTIONS

- A. Provide required wiring, raceways and final connections for all equipment provided by this Division and Divisions 1 thru 23.
- B. Make final connections in accordance with wiring diagrams obtained from equipment manufacturer.
- C. Rough-in in accordance with approved shop drawings from the manufacturer or supplier of the equipment. Rough-in prior to shop drawing approval will be subject to change without adjustment to contract cost.

3.18 BALANCING

- A. The system of feeder and branch circuits for power and lighting shall be connected to panel busses in such a manner as to electrically balance the connected load as close as is practicable. Should the Owner disclose any unfavorable conditions reacting on the service, this Contractor shall make such changes as may be suggested to balance the load.

3.19 GUARANTEE

- A. All work shall be guaranteed to be free from defects for a period of two years of operation from date of acceptance by the Owner unless otherwise specified in Division 1.
- B. Guarantee shall be extended on an equal time basis for all non- operational periods due to failure

within the guarantee period.

- C. Contractor to include an 11 month “walk-thru” of the building system with representatives of the School District, Architect, Engineer and the Construction Manager. The purpose is to establish a list of corrective work that relates to operational issues, material/installation deficiencies.

END OF SECTION 26 0000

SECTION 26 00 55
ELECTRICAL IDENTIFICATION**PART 1 – GENERAL****1.1 RELATED DOCUMENTS**

- A. This section is a Division 26 Basic Materials and Methods Section, and is part of each Division 26 Section making reference to electrical identification specified herein.

1.2 DESCRIPTION OF WORK

- A. Types of electrical identification specified in this section include the following:
 - Cable conductor identification.
 - Operational instructions and warnings.
 - Danger signs.
 - Equipment/system identification signs.

PART 2 – PRODUCTS**2.1 MANUFACTURERS**

- A. Subject to compliance with requirements, provide products of one of the following (for each type of marker):
 - W. H. Brady Co.
 - Ideal Industries, Inc.
 - Seton Name Plate Co.
 - 3M Electrical Products

2.2 ELECTRICAL IDENTIFICATION MATERIALS

- A. Provide manufacturer's standard products of categories and types required for each application. Where more than single type is specified for an application, selection is Installer's option, but provide single selection for each application.

2.3 COLOR-CODED PLASTIC TAPE

- A. Provide manufacturer's standard vinyl tape not less than 7 mils thick by 3/4" wide.
- B. Colors: Unless otherwise indicated or required by governing regulations, provide tape color as indicated in Paragraph 3.2.B.
- C. Tape shall be of Type 3M Scotch 35 for color coding, Scotch Super 33+ for splices and Tem Flex 1700 for general use.

2.4 CABLE/CONDUCTOR IDENTIFICATION BANDS

- A. Provide manufacturer's standard vinyl cloth, self-adhesive cable/conductor markers of wrap-around type; either pre-numbered, plastic-coated type, or write-on type with clear plastic, self-adhesive cover flap; numbered to show circuit identification.

2.5 BAKED ENAMEL DANGER SIGNS

- A. Provide manufacturer's standard "DANGER" signs of baked enamel finish on 20-gage steel; of standard red, black and white graphics; 14" x 10" size except where 10"x 7" is the largest size which can be applied where needed, and except where larger size is needed for adequate vision; with recognized standard explanation wording (as examples: HIGH VOLTAGE, KEEP AWAY, BURIED CABLE, DO NOT TOUCH SWITCH).

2.6 ENGRAVED PLASTIC-LAMINATE SIGNS

- A. Provide engraved stock melamine plastic laminate, in sizes and thicknesses indicated, engraved with engraver's standard letter style of sizes and wording indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
- B. Thickness: 1/16" for units up to 20 sq. in. or 8" length; 1/8" for larger units.
- C. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate substrate.

2.7 LETTERING AND GRAPHICS

- A. Coordinate names, abbreviations and other designations used in electrical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of electrical systems and equipment.

PART 3 – EXECUTION

3.1 APPLICATION AND INSTALLATION

- A. Coordination: Where identification is to be applied to surfaces which require finish, install identification after completion of painting.
- B. Regulations: Comply with governing regulations and requests of governing authorities for identification of electrical work.

3.2 CABLE/CONDUCTOR IDENTIFICATION

- A. Apply cable/conductor identification on each cable and conductor in each box/enclosure/cabinet where wires of more than one circuit or communication/signal system are present. Match identification with marking system used in panelboards, shop drawings, contract documents, and similar previously established identification for project electrical work.
- B. Conductor Color Coding:
 - 1. All conductors used in all systems shall have insulation that is inherently colored. All conductors of a system performing the same function shall be colored alike throughout the project.
 - 2. Equipment Grounding Conductors:
 - a. Standard and/or general feeders or circuits shall be green.
 - b. Isolated feeders or circuits shall be green with yellow stripe.
 - 3. On larger conductors, where colored insulation is not available, colored tape adhesive vinyl bands 3/4" width may be installed 6" maximum from the end of the conductors. Where passing through pull boxes without splice, each conductor shall be banded.
 - 4. Power system conductor colors shall be as follows:
 - a. 120/208 Volt System
 - Phase A - Black
 - Phase B - Red
 - Phase C - Blue
 - Neutral - White or Gray
 - b. 277/480 Volt System
 - Phase A - Brown
 - Phase B - Orange
 - Phase C - Yellow

Neutral - White or Gray

3.3 DANGER SIGNS

- A. In addition to installation of danger signs required by governing regulations and authorities, install appropriate danger signs at locations indicated and at locations subsequently identified by Installer of electrical work as constituting similar dangers for persons in or about project.
- B. High Voltage: Install danger signs wherever it is possible, under any circumstances, for persons to come into contact with electrical power voltages higher than 110-120 volts.

3.4 EQUIPMENT/SYSTEM IDENTIFICATION

- A. Install engraved, plastic laminate sign on each major unit of electrical equipment in building, including central or master unit of each electrical system including communication/signal systems, unless unit is specified with its own self-explanatory identification or signal system. Except as otherwise indicated, provide single line of text, 1/2" high lettering on 1-1/2" high sign (2" high where 2 lines are required), white lettering in black field. Provide text matching terminology and numbering of the contract documents and shop drawing. Provide signs for each unit of the following categories of electrical work:
 - 1. Panelboards, electrical cabinets and enclosures.
 - 2. Access panel/doors to electrical facilities.
 - 3. Major electrical switchgear, main and feeder circuit breakers and/or disconnects..
 - 4. Power transfer equipment.
 - 5. Fire Alarm Master Station and Annunciator.
 - 6. Paging and Intercommunication Systems
 - 7. Security Control Panels and Annunciator.
- B. Install signs at locations for best convenience of viewing without interference with operation and maintenance of equipment. Secure to substrate with fasteners, except use adhesive where fasteners should not or cannot penetrate the substrate.

3.5 JUNCTION AND PULL BOX IDENTIFICATION

- A. Emergency Systems: Each junction and pull box cover shall be painted orange. Use black indelible liquid marker to label "EMERG." in 3/8" letters minimum.
- B. Fire Alarm System: Each junction and pull box cover shall be painted red. Use black indelible liquid marker to label "F.A." in 3/8" letters minimum.
- C. Feeders Shown on Single Line Diagram: Each junction and pull box shall be marked with black indelible liquid marker with the assigned feeder number "FDR #38" in 3/8" letters minimum.

END OF SECTION 26 0055

SECTION 26 01 10
RACEWAYS**PART 1 – GENERAL****1.1 RELATED DOCUMENTS**

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary and other conditions, if any) and Division 1 as appropriate, apply to the Work specified in this Section.
- B. Refer to Section 260000 for General Provisions - Electrical.

1.2 DESCRIPTION OF WORK

- A. Types of raceways in this section include the following:
 - Rigid metal conduit
 - Intermediate metal conduit
 - Electrical metallic tubing.
 - Polyvinyl chloride conduit (Exterior Underground Only)
 - Flexible metal conduit.
 - Liquid-tight flexible metal conduit.
 - Multi-Cell Raceway
 - Wireways.

1.3 REFERENCE STANDARDS

- A. Refer to Section 260000 for a general description of requirements applying to this Section.

1.4 QUALITY ASSURANCE

- A. Refer to Section 260000 for a general description of requirements applying to this Section.

1.5 WARRANTY/GUARANTEE

- A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, GENERAL REQUIREMENTS.

1.6 COORDINATION

- A. The drawings and details there upon are scheme and/or diagrammatic in nature, and indicate the need and intent of the design. These are to be used for general guidance only. It shall be the responsibility of the Electrical Contractor to coordinate, with other Division Subcontractors, the installation of all raceways, raceway supports, junction boxes and required fittings. This coordination will include conduit layout to allow access to equipment for maintenance.
- B. This coordination shall be carried out prior to actual installation; this shall be done to eliminate the possibility of conflicts between trades on items such as access, clearances and maintenance issues that may arise after completion of construction.
- C. Should the coordination not be carried out prior to installation, and a conflict exists, the installing contractor shall remove and reinstall the equipment as required to clear the conflict at no additional cost to the Owner and no delay in project completion.

PART 2 – PRODUCTS**2.1 MATERIALS AND EQUIPMENT**

- A. Rigid Metal Conduit:
 - 1. Raceway: Full weight, heavy wall rigid steel with zinc coating conforming to ANSI-C80.1.

2. Fittings: Cast malleable iron fittings with threaded hubs, insulated throat and zinc protective coating.
 3. Subject to compliance with requirements, provide products of one of the following:
Allied Tube and Conduit Corporation
LTV Steel Tubular Products Co.
Wheatland Tube
- B. Intermediate Metal Conduit:
1. Raceway: Light weight, rigid steel, hot dipped galvanized manufactured in accordance with UL1242.
 2. Fittings: Cast malleable iron fittings with threaded hubs, insulated throat and zinc protective coating.
 3. Subject to compliance with requirements, provide products of one of the following:
Allied Tube and Conduit Corporation
LTV Steel Tubular Products Co.
Wheatland Tube
- C. Electrical Metallic Tubing:
1. Raceway: Light weight, thin wall, rigid steel, hot dipped galvanized manufactured in accordance with ANSI C80.3.
 2. Fittings: Raintight, insulated throat, compression type with zinc protective coating.
 3. Subject to compliance with requirements, provide products of one of the following:
Allied Tube and Conduit Corp.
LTV Steel Tubular Products Co.
Wheatland Tube Co.
- D. Polyvinyl Chloride Conduit:
1. Raceway: Heavy wall, rigid non-metallic, schedule 40 with bell type end, designed for above ground exposed applications, direct earth burial, and concrete encasement.
 2. Fittings: Polyvinyl chloride, heavy duty, glue type, designed for Schedule 40 application.
 3. Subject to compliance with requirements, provide products of one of the following:
Allied Tube & Conduit
Carlton
Queen City Plastics, Inc.
Scepter Electric Systems
Cantex, Inc.
- E. Flexible Metal Conduit:
1. Raceway: Construct of single strip, flexible, continuous, interlocked, and double-wrapped steel, galvanized inside and outside.
 2. Fittings: Steel, insulated throat, with zinc protective coating.
 3. Subject to compliance with requirements, provide products of one of the following:
AFC
Alflex Corp.

Electri-Flex Company

F. Liquid-Tight Flexible Metal Conduit:

1. Raceway: Construct of single strip, flexible, continuous, interlocked, and double-wrapped, galvanized inside and outside, coat with liquid-tight jacket of flexible polyvinyl chloride.
2. Fittings: Steel, water and oiltight, insulated throat, with zinc protective coating.
3. Subject to compliance with requirements, provide products of one of the following:
AFC
Alflex Corp.
Electri-Flex Company

G. Multi-Cell Raceway

1. Raceways: Shall be a multi-cell raceway system for concrete encasement applications, 20 ft. lay length sections of 4" PVC outer shell type C with four (4) 1-1/4" nominal pre-lubed PVC innerducts pre-installed. The innerducts shall be color coded (white/grey/orange/green). Raceway shall be similar to Carlon Telecom System Part No. MXSS4S-020.
2. Fittings: Raceway shall be provided with a complete line of, but shall not necessarily be limited to, couplings, offsets, 90 deg., 36" radius bends, adapters, hold-down clips, end-caps and other accessories as needed for a complete system.

H. Wireways:

1. Furnish electrical wireways of the type, size, and style for each service indicated. Wireway shall be a complete assembly including but not necessarily limited to, couplings, offsets, elbows, adapters, hold-down clips, end-caps and other components and accessories as needed for a complete system.
2. System shall fulfill wiring requirements as indicated in contract documents, and shall comply with applicable portions of Article 362 of the National Electrical Code.
3. Subject to compliance with requirements, provide products of one of the following:
Circle AW Products Co.
The EMF Company, Inc.
Hoffman Engineering Company
Square "D" Company

- J. The above items shall include the statement "Approved Equal" and/or "Approved Substitute". This statement requires that the product or item be in compliance with the written intent of this specification and the submission meets the requirements of Section 260000.

PART 3 – EXECUTION**3.1 INSTALLATION OF ELECTRICAL RACEWAYS**

- A. Install electrical raceways in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA "Standard of Installation", and complying with recognized industry practices.
- B. Coordinate with other work as necessary to interface installation of electrical raceways, wireways and required components.
- C. Raceways used for distribution, feeders, or branch circuits shall be a minimum size of 3/4" or equal equivalent cross-sectional area. Raceways used for control and signal shall be a minimum size of 1/2" or equal equivalent cross-sectional area.
- D. All raceways shall be concealed within the building construction.

- E. All raceways installed in ceiling cavities and exposed within mechanical spaces shall be run parallel with building lines and installed level and square at the proper elevation/height.
 - F. Complete the installation of electrical raceways before starting the installation of cables/wires within the raceway.
 - G. Furnish and install one (1) nylon or fiberglass pull cord in each empty raceway. Each empty raceway shall be cleaned, capped, and tagged as to its termination location.
 - H. Install liquid-tight flexible metal conduit for connections to motors and for other electrical equipment when subject to movement and vibration, and also where subjected to one or more of the following conditions:
 - 1. Exterior locations.
 - 2. Moist or humid atmosphere when condensation can be expected to accumulate.
 - 3. Corrosive atmosphere.
 - 4. Subjected to water spray.
 - 5. Subjected to dripping oil, grease or water.
 - I. Install Electrical Metallic Tubing for building interior electrical work except:
 - 1. Underground
 - 2. In gravel, cinder, concrete or other sub-base floor construction.
 - 3. Horizontal runs in concrete floor slabs.
 - 4. Where exposed to the elements.
 - 5. In masonry construction below finished grade.
 - 6. Vertically in poured concrete walls.
 - J. Refer to Section 260000 for excavation, shoring and pumping, concrete and backfilling requirements.
 - K. Where and whenever possible, install horizontal electrical raceways as tight to building construction as possible and above water, drain and steam piping. A separation of at least six (6) inches shall be maintained between electrical conduits and hot water and steam piping.
 - L. In accordance with NEC requirements, install Rigid or Intermediate Metal Conduit where Electrical Metallic Tubing is not permitted.
 - M. In all instances where recessed type panelboards are installed, furnish and install one (1) one-inch raceway for each two (2) future circuits for which "space" or "spare" provisions have been made in the panelboard. These raceways shall extend between the panelboard cabinet and a convenient location above an access panel or a removable tile ceiling construction and capped.
- 3.2 CLEANING
- A. Upon completion of installation of raceways, inspect interiors of raceways; remove burrs, dirt and construction debris.

END OF SECTION 26 0110

SECTION 26 01 20 WIRES AND CABLES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. This section is a Division 26 Basic Materials and Methods section and is part of each Division 26 Section making reference to wires and cables specified herein.

1.2 DESCRIPTION OF WORK

- A. Electrical wire and electrical cable work is indicated by drawings and specifications.
- B. Types of wire, cable and connectors in this section include, but not limited to the following:
Copper conductors.
Tap type connectors.
Split-bolt connectors.
- C. Refer to other sections of Division 26 for, but not limited to, raceways, connections used in conjunction with wire and cable work.
- D. Applications for wire, cable and connectors required for project are as follows unless otherwise indicated:
 - 1. Primary Service Circuitry.
 - 2. Power Distribution Circuitry.
 - 3. Appliance and Equipment Circuitry.
 - 4. Motor Branch Circuitry.
 - 5. Control Circuitry.
 - 6. Signal/Communication Circuitry.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Wire and Cable
Anaconda Wire and Cable Co.
Advance Wire and Cable, Inc.
American
Cerro Wire and Cable Co.
Electrical Conductors, Inc.
General Cable Corp.
Hitemp Wires, Inc.
Rome Cable Corp.
Southwire Company
Triangle PWC,, Inc.
The Okonite Co.
General Electric Co.
Rockbestos Surprenant Cable Corp.
Prysonian (Pirelli)

Connectors

Burndy Corp.

Eagle Electric Mfg. Co., Inc.

Gould, Inc.

Ideal Industries, Inc

Joslyn Mfg. and Supply Co.

O-Z/Gedney Co.

Pyle National Co.

Thomas and Betts Co.

2.2 WIRE, CABLE AND CONNECTIONS

- A. Except as otherwise indicated, provide wire, cable and connectors of manufacturer's standard materials, as indicated by published product information; designed and constructed as recommended by manufacturer, and as required for the installation. Minimum wire and cable size is #12 AWG for power and branch circuits and #14 AWG for control and signal/communication circuits unless otherwise indicated.
- B. Wire: Provide factory fabricated wire of sizes, ratings, materials and types indicated for each service. Where not indicated, provide proper selection as determined by Installer to comply with project's installation requirements and NEC standards. Select from the following types, materials, conductor configurations, insulation and coverings:
- UL Type: THHN
- UL Type: TW
- UL Type: THW
- UL Type: THWN
- UL Type: TF
- UL Type: XHHW
- UL Type: MC (Metal Clad)
- Material: Copper
- Conductors: Solid (AWG 14 to AWG 10 only).
- Conductors: Concentric-lay-stranded (standard flexibility)
- Outer Covering: Nylon
- Outer Covering: Thermoplastic
- C. Connectors: Provide factory fabricated metal connectors of sizes, ratings, materials, types and classes as required for each service. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements and NEC standards. Select from the following types, classes, kinds and styles.
- Type: Pressure
- Type: Crimp
- Type: Threaded
- Class: Insulated
- Class: Non-insulated
- Kind: Copper (for CU to Cu connection).

Style: Butt connection

Style: Elbow connection

Style: Combined "T" and straight connection

Style: "T" connection.

Style: Split-bolt parallel connection

Style: Tap connection

Style: Pigtail connection

- D. 25KV Cable: Provide factory fabricated and tested primary service cable; underground residential distribution (URD) type cable, size #1/0 AWG solid aluminum and #4/0 AWG copper conductor with 25KV cross-linked polyethylene insulation (XLP) with tinned or coated copper wire full size concentric neutral as approved by the Utility Company.
- E. 25KV Terminations: Provide 25KV terminations for 25KV #1/0 AWG solid and #4/0 AWG copper aluminum cable.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Install electrical cables, wires and connectors, in compliance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in accordance with recognized industry practices.
- B. Coordinate cable and wire installation work with electrical raceway and equipment installation work, as necessary for proper interface. Pull conductors together where more than one is being installed in a raceway. Use pulling compound or lubricate, where necessary; compound must not deteriorate conductor or insulation. Use pulling means including fish tape, cable or rope which cannot damage raceway. Rope must be used as pulling means when pulling wires or cables into plastic conduit and duct. Keep conductor splices to a minimum and install in junction boxes only. No splices shall be permitted within conduit. Install splices and tapes which have mechanical strength and insulation rating equivalent or better than conductor. Use splice and tape connectors which are compatible with conductor material.
- C. Installation of 25KV primary service cable.
- D. 25KV cable terminations.

3.2 FIELD QUALITY CONTROL

- A. Prior to energization, test cable and wire for continuity of circuitry and also for short circuits. Correct malfunctions when detected.
- B. Subsequent to wire and cable hook-ups, energize circuitry and demonstrate functioning in accordance with requirements.
- C. Test 25KV cable after installation using D.C. high potential (Hi-Pot) testing. All testing shall be performed in accordance with cable manufacturer's recommended specifications. Keep a complete record of all tests and submit to the Engineer upon completion. Testing shall be performed by an independent cable testing company or service.

END OF SECTION 26 0120

SECTION 26 01 30 MANHOLES

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of manholes and manhole installation work is indicated by drawings and specifications.
- B. Types of manholes in this section shall include the following:
 - 1. Precast concrete
 - 2. Poured in place

1.2 SUBMITTALS

- A. Submit manufacturer's data on manholes including, but not limited to, roughing-in drawings, construction details and structural support data.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with requirements, provide manholes with frame and cover, and cable accessories of one of the following:
 - 1. Manholes - A.C. Miller Concrete Products, Inc.
- Gillespie Precast, LLC
 - 2. Frame and Cover - Neenah Foundry Co.

2.2 STANDARD MANHOLES

- A. Manholes shall be a precast concrete box with interior dimensions of 48" wide x 48" long x 48" deep with 6" walls, floor and top.
- B. Floor shall be provided with a ground rod hole, pulling irons and a 12" diameter x 12" deep sump.
- C. Top shall be a precast 6" slab with a circular opening suitable for a manhole frame opening of 32-1/2".
- D. The precast 6" top slab shall be sealed where it joins the manhole. The entire exterior surface of the manhole shall be coated with a bitumastic type waterproof coating prior to installation.

2.3 MANHOLE FRAME AND COVER

- A. Frame and cover shall be a round, heavy duty, cast iron frame and solid cover with machined horizontal bearing surfaces. Total weight to be approximately 365 pounds.
- B. Frame and cover dimensions shall be as follows:
 - 1. Overall frame size = 38-1/2"
 - 2. Clear opening size = 32-1/2"
 - 3. Overall frame height = 4"
- C. Cover shall have the word, "Electric", cast into it.
- D. Frame and cover shall be similar in manufacture to Neenah Foundry Company Model No. R-1792-HL.

2.4 GROUND ROD AND CLAMP

- A. Ground rod shall be a rigid steel rod with a heavy duty, uniform, non-porous copper coating. Rod to be 3/4" dia. x 10'-0" long. Clamp to be cast of high copper content bronze alloy.
- B. Ground rod assembly to consist of the following:
 - 1. Ground rod - Blackburn Cat. No. W5810

2. Ground Clamp - Blackburn Cat. No. J-JR.

PART 3 – EXECUTION

3.1 INSTALLATION OF MANHOLES

- A. Install manholes in accordance with manufacturer's written instructions and complying with applicable portions of NEC and NECA's "Standard of Installation."
- B. Manholes shall be oriented in accordance with duct bank requirements as indicated on the electrical site plan. The depth of the manhole shall be as required to allow the frame and cover to set level with finished grade.
- C. Manholes shall not be set in an area or at an elevation which will allow surface water or runoff to enter manhole through the cover. Should this occur, this Contractor will be required to raise the frame and cover and regrade the area.

3.2 FIELD QUALITY CONTROL

- A. Contractor shall inspect the conduit entrances into the manhole looking for broken ducts and/or rough edges and repairing the findings. Contractor shall also check that conduit entrances are sealed to keep out ground water.
- B. All manholes shall be cleaned of dirt and construction debris. All spare conduits shall have a nylon pull cord installed for future use.

END OF SECTION

SECTION 26 01 35
ELECTRICAL BOXES & FITTINGS**PART 1 – GENERAL****1.1 RELATED DOCUMENTS**

- A. This section is a Division 26 Basic Materials and Methods section, and is a part of each Division 26 section making reference to electrical wiring boxes and fittings specified herein.

1.2 DESCRIPTION OF WORK

- A. Types of electrical boxes and fittings in this section include the following:

Outlet boxes.

Junction boxes.

Pull boxes.

Conduit bodies.

Bushings.

Locknuts.

Knockout closures.

PART 2 – PRODUCTS**2.1 INTERIOR METALLIC OUTLET BOXES**

- A. Provide galvanized flat rolled sheet steel interior outlet non-gangable wiring boxes, of types, shapes and sizes, including box depths, to suit each respective location and installation; construct with stamped knockouts in back and sides and with threaded screw holes with corrosion-resistant screws for securing box covers and wiring devices.
- B. Provide outlet box accessories as required for each installation, including mounting brackets, wallboard hangers, extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, which are compatible with outlet boxes being used and fulfilling requirements of individual wiring situations. Choice of accessories is Installer's option.
- C. Manufacturer: Subject to compliance with requirements, provide interior outlet boxes of one of the following:

Appleton Electric Co.

Bell Electric/Square D Co.

Pass and Seymour, Inc.

RACO, Inc.

Steel City/Midland-Ross Corp.

2.2 WEATHERPROOF OUTLET BOXES

- A. Provide corrosion resistant cast-metal weatherproof outlet wiring boxes, of types, shapes and sizes, including depth of boxes, with threaded conduit ends, cast-metal face plates with spring-hinged waterproof caps suitably configured for each application, including face plate gaskets and corrosion-resistant fasteners.
- B. Manufacturer: Subject to compliance with requirements, provide weatherproof outlet boxes of one of the following:

Arrow-Hart Div., Crouse-Hinds Co.

Bell Electric/Square D Co.

Harvey Hubbell, Inc.

O-Z/Gedney Co.

Slater Electric Co.

2.3 JUNCTION PULL BOXES

- A. Provide galvanized code-gauge sheet steel junction and pull boxes, with screw-on covers; of types, shapes and sizes, to suit each respective location and installation; with welded seams and equipped with stainless steel nuts, bolts, screws and washers.

- B. Manufacturers: Subject to compliance with requirements, provide junction and pull boxes of one of the following:

Adalet-PLM Div., Scott and Fetzer Co.

Appleton Electric Co.

Arrow-Hart Div., Crouse-Hinds Co.

Bell Electric/Square D Co.

GTE Corporation

Keystone Columbia, Inc.

O-Z/Gedney Co.

Slater Electric Co.

Spring City Elect. Mfg. Co.

2.4 CONDUIT BODIES

- A. Provide galvanized cast-metal conduit bodies, of types, shapes, and sizes, to suit respective locations and installation, construct with threaded-conduit-entrance ends, removable covers, and corrosion-resistant screws.

- B. Manufacturers: Subject to compliance with requirements, provide conduit bodies of one of the following:

Appleton Electric Co.

Crouse-Hinds Co.

Gould, Inc.

Killark Electric Mfg. Co.

O-Z/Gedney Co.

Spring City Electrical Mfg. Co.

2.5 BUSHINGS, KNOCKOUT CLOSURES AND LOCKNUTS

- A. Provide corrosion-resistant punched-steel box knockout closures, conduit locknuts and insulated malleable iron conduit bushings, offset connectors, of types and sizes to suit respective uses and installation.

- B. Manufacturers: Subject to compliance with requirements, provide bushings, knockout closures, locknuts and connectors of one of the following:

Appleton Electric Co.

Burndy Corp.

Crouse-Hinds Co.

Gould, Inc.

O-Z/Gedney Co.

RACO, Inc.

Steel City/Midland-Ross Corp.

Thomas and Betts Co., Inc.

PART 3 – EXECUTION

3.1 INSTALLATION OF ELECTRICAL BOXES AND FITTINGS

- A. Install electrical boxes and fittings, complying with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.
- B. Coordinate installation of electrical boxes and fittings with wire/cable and raceway installation work.
- C. Provide weatherproof outlets for interior and exterior locations exposed to weather or moisture.
- D. Provide knockout closures to cap unused knockout holes where blanks have been removed.
- E. Install boxes and conduit bodies in those locations to ensure ready accessibility of electrical wiring.
- F. Avoid using round boxes where conduit must enter box through side of box, which would result in difficult and insecure connections when fastened with locknut or bushing on rounded surface.
- G. Fasten boxes rigidly to substrates or structural surfaces to which attached, or solidly embed electrical boxes in concrete or masonry.
- H. Provide electrical connections for installed boxes.
- I. Pull boxes and junction boxes shall be furnished and installed in all conduit runs at intervals not exceeding 100 feet maximum.
- J. Identify each circuit in all pull boxes and junction boxes whether the box contains one or more circuits.

END OF SECTION

SECTION 26 01 40 WIRING DEVICES

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK

- A. The extent of wiring device work is indicated by drawings, schedules and specifications. Wiring devices are defined as single discrete units of the electrical distribution system which are intended to carry but not utilize electric energy.
- B. Types of electrical wiring devices in this section include the following:
 - Receptacles.
 - Switches.
 - Device plates.
 - Contactors
 - Energy Control Devices

1.2 SUBMITTALS

- A. Product Data: Submit manufacturer's data on electrical wiring devices.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products of one of the following (for each type of wiring device):
 - Legrand Co.
 - Hubbell, Inc.
 - Leviton Mfg. Co.
 - Lutron Electronics Co., Inc.
 - Square D Co.
 - Eaton Corp.
 - Siemens
 - Wattstopper

2.2 FABRICATED WIRING DEVICES

- A. Provide factory fabricated wiring devices, in types, styles, colors, and electrical ratings for applications indicated and complying with NEMA Standards Pub. No. WD 1. Where types and grades are not indicated, provide proper selection as determined by Installer to fulfill wiring requirements, and complying with NEC and NEMA Standards for wiring devices. Color selection to be verified by Contractor with Architect/Engineer.

2.3 RECEPTACLES

- A. All simplex receptacles shall be extra heavy duty, 20 amperes, 125 volts, 2 pole, 3 wire grounding, with green hexagonal equipment ground screw, with metal plaster ears, side wiring, NEMA configuration 5-20R unless otherwise indicated. Hubbell Cat. #HBL5361 or approved substitute.
- B. All duplex receptacles shall be extra heavy duty, 20 amperes, 125 volts, 2 pole, 3 wire grounding type with green hexagonal equipment ground screw, with metal plaster ears, side wiring, NEMA configuration 5-20R and tamper-proof unless otherwise indicated. Hubbell Cat. #HBL5362TR or approved substitute.

- C. Special Purpose Receptacles: Provide polarized grounding type special purpose receptacles of the required amperage and voltage ratings, extra heavy duty. Device shall include a green hexagonal equipment ground screw.
- D. All ground fault receptacles shall be extra heavy-duty duplex, tamper resistant, 20 amperes, 125 volts, 2 pole, 3 wire grounding type with green hexagonal equipment ground screw, integral ground fault circuit interrupter, UL rated Class A, Group 1, with metal plaster ears, side wiring, NEMA Configuration 5-20R, self-testing with red and green LED indicator lights. Device shall include solid state ground-fault sensing and signaling, with a 5 milliampere ground fault trip level, plus or minus 1 milliampere. Hubbell Cat. #GFR5362SG or approved substitute.
 - 1. Whether indicated or not on the floor plans, the Electrical Contractor shall furnish and install GFI protected devices in kitchen areas on countertops near sinks, water coolers, refrigerators, on rooftop equipment, on exterior walls; and as indicated by the N.E.C., it shall be the discretion of the Electrical Contractor to provide GFI receptacles or GFI circuit breaker. Receptacles protected by GFI circuit breakers shall be permanently labeled on the faceplate as GFCI.
- E. All Isolated Ground Duplex Receptacles shall be extra heavy duty, hospital grade, 20 amperes, 125 volts, 2 pole, 3 wire isolated ground with metal plaster ears, isolated from ground circuit, side wiring, NEMA configuration 5-20R and tamper-proof unless otherwise indicated. Devices shall be color coded with an orange face and black triangle to identify all isolated ground devices. Hubbell Cat. #IG5362, or approved substitute.

2.4 SWITCHES

- A. Toggle Switch: Provide extra heavy duty, industrial series flush toggle, 1 pole, 2 pole, 3-way, 4-way AC quiet switch rated 20 amperes @ 120/277 volts with green hexagonal equipment ground screw, metal plaster ears, and side wired screw terminals. Similar to Hubbell Series HBL Series or approved substitute.
- B. Toggle Switch with Pilot Light: Provide extra heavy duty industrial series, flush toggle, single pole, AC quiet switch rated 20 amperes @ 120 volts with green hexagonal equipment ground screw, metal plaster ears, side-wired screw terminals and 1/25 watts, 125-volt neon pilot light, designed to mount within a single gang outlet box. Similar to Hubbell HBL or approved substitute.
- C. Key Switch: Provide extra heavy duty, industrial, 1 pole, 2 pole, 3-way, 4-way barrel key locking switch rated at 20 AMPs @ 120/277 volts with green grounding screw, metal plaster ears and side wired screw terminals. The tumbler shall be a six-point cylinder type. All project keyed switches to be keyed alike. Similar to Hubbell 122*RKL series.

2.5 DEVICE PLATES

- A. Provide switch and receptacle outlet wall plates for wiring devices, of types, sizes, and with ganging and cut outs required by the devices being installed. Construct with metal screws for securing plates to devices; screw heads colored to match finish of plates; plates colored to match wiring devices to which attached. **All emergency receptacles to have red coverplates.** Provide device plates possessing the following additional construction features: **Receptacle outlet plates to be permanently marked with panel designation and circuit number on back side of plate.**
 - 1. Metal Plates to be stainless steel of non-corrosive and non-magnetic 302 alloy, .032" nominal thickness. Plates shall have brushed satin finish.
 - 2. Non-Metallic Plates to be a thermoplastic, virtually indestructible, molded polycarbonate material offering resistance to impact, scratches, discoloration and be self-extinguishing. Plates shall have no-line smooth finish.
- B. Weatherproof device plates shall have spring-hinged waterproof cap suitably configured for each application, including face plate gaskets and corrosion-resistant fasteners.

- C. Existing mechanical spaces where concealed work is impractical, such as masonry or block walls, Provide 4" square boxes, surface mounted, with 1/2" deep surface mounted device plates consisting of same material for devices indicated on plans, whether single or double gang. Use of plaster flange and standard cover plate will not be acceptable.

2.6 CONTACTORS

- A. Electrically Held Power Lighting Contactor: Shall be rated 30 to 200 AMPs for 2 thru 5-pole versions and 300 to 800 AMPs for 2 and 3 pole versions, as indicated on the Floor Plan. Contactor shall have factory wired control and clearly marked termination points, designed for mixed load ratings with a UL listed short-circuit rating up to 100,000 amperes. Contactor shall be housed in a NEMA Type I, general purpose enclosure and be similar to Square D Company, Type "S", Class 8903 or approved substitute.
- B. Mechanically Held Power Lighting Contactor: Shall be rated 30 to 200 AMPs for 2 thru 5 pole versions and 300 to 800 AMPs for 2 and 3 pole versions, as indicated on the Floor Plan. Contactor shall have factory wired control with coil clearing contacts and clearly marked termination points, designed for mixed load ratings with a UL listed short-circuit rating up to 100,000 amperes. Contactor shall be housed in a NEMA Type I, general purpose enclosure and be similar to Square D Company, Type "S", Class 8903 or approved substitute.
- C. Multiple Lighting Contactor: Shall be an electrically or Mechanically held device with 2 thru 12 poles rated 30 AMPs ballast and 20 AMPs tungsten, as indicated. Mechanically held contactor shall have factory wired control with coil clearing contacts and clearly marked termination points. Contactor shall be housed in a NEMA Type I, general purpose enclosure and be similar to Square D Company Types "L" and "LX", Class 8903 or approved substitute.
- D. General: All contactor control setups shall include all required interface relays needed to function with maintained or momentary contact switches, time clocks and photocell controls. Control circuits and coil voltages shall be 120 volts A.C. single phase. Where system voltage is 277/480 volts, a control power transformer shall be furnished and installed within the contactor enclosure. Transformer shall be sized to handle the contactor's coil load as well as all associated control devices.

2.7 ENERGY CONTROL DEVICES (Occupancy Sensors)

- A. Line Voltage:
 - 1. Combination wall switch and sensor shall be Dual Technology Passive Infrared and Ultrasonic, designed for single gang outlet box installation, with a coverage of 180° for a maximum of 400 square feet. Device shall be suitable for 120/277 dual voltage operation, and have vandal resistant, hard sensor lens. Device shall be similar to Sensor Switch Cat. No. WSD-PDT or Wattstopper DW-100 Series, DW-103 Series for multi-way, DW-200 for dual relay, DW-203 for multi-way dual relay, or approved substitute.
 - 2. Ceiling sensor shall be Dual Technology Passive Infrared and Ultrasonic 360° coverage, 1200 square feet maximum. Self Contained Relay Device shall be suitable for 120/277 Dual Voltage operation. Device shall be similar to Sensor Switch Cat. No. CMR-PDT, Wattstopper DT-355 or approved substitute.
- B. Low Voltage:
 - 1. Ceiling mounted sensor shall be Dual Technology Passive Infrared and Ultrasonic with 360° coverage up to 20 feet. Device accepts 12 to 24 volt AC or DC. Device shall be similar to Sensor Switch Cat. No. CM-PDT or approved substitute.
 - 2. Sensor power pack shall be a low voltage power supply with an input of either 120 volts or 277 volts AC and an output of 24 volts DC @ 150 mA. Device shall contain a 20 AMP isolated load control relay. When relay is used, power supply output shall be reduced to 24 volts DC @ 114 mA. Device shall be similar to Sensor Switch PP-20 or approved substitute.

C. Photocontrol

1. Provide epoxy conformal coated cadmium sulphide photocell with Lexan impact and vandal resistant enclosure. Dome and base to be ultrasonically welded. Photocell shall respond to the light spectrum near to that of a human eye. Housing shall mount to ½" conduit and have 180° swivel.
2. Photocell shall have on/off time delay, on at 1 to 5 FC, off at 3 to 15 FC. Tool free adjustment. Unit shall fail in the ON position.
3. Unit shall operate from -40°F to 140°F, with a minimum 5-year warranty.
4. Provide Tork 2001 series or approved equivalent.

PART 3 – EXECUTION

3.1 INSTALLATION OF WIRING AND CONTROL DEVICES

- A. Install wiring devices as indicated, in compliance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in accordance with recognized industry practices to fulfill project requirements.
- B. Coordinate with other work, including painting, electrical box and wiring work, as necessary to interface installation of wiring devices with other work.
- C. Install wiring devices only in electrical boxes which are clean, free from building materials, dirt and debris.
- D. Provide electrical connections for wiring and control devices.
- E. Delay installation of all wiring and control devices until wiring work is completed.
- F. Isolated Ground Receptacle Devices shall be connected to the system ground by way of an insulated ground conductor color coded green with a yellow stripe.

3.2 PROTECTION OF WALL PLATES AND RECEPTACLES

- A. At time of Substantial Completion, replace those items which have been damaged, including those burned and scorched by faulty plugs.

3.3 GROUNDING

- A. Provide electrically continuous, tight grounding connections for wiring and control devices.

3.4 TESTING AND COMMISSIONING

- A. Prior to energizing circuitry, test wiring devices for electrical continuity and proper polarity connections. After energizing circuitry, test wiring devices to demonstrate compliance with requirements.
- B. After energizing circuitry, the Electrical Contractor shall test and adjust all control devices to provide optimum operation and performance.
- C. All areas where energy control devices are specified shall be verified for full coverage and accurate operation. If any area is determined by the Owner, Architect, or Engineer to have inadequate coverage or operation, Contractor shall provide additional energy control devices to remedy the coverage or operation issue. For bidding purposed, own 5 extra devices fully installed. After successful commissioning, uninstalled devices shall be handed over to the Owner for spare devices. Device types shall be as required for commissioning, or as selected by Owner for space devices as applicable.

END OF SECTION

SECTION 26 01 55

MOTOR STARTERS

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of motor starter work is indicated by drawings, schedules and specifications.
- B. Refer to sections of other divisions of these specifications for driven equipment specified without motor starters. Motor starters for such equipment are the work of this section.
- C. Types of motor starters in this section include the following:
Manual.
Magnetic Full Voltage, Non-Reversing.
Combination Disconnect Switch and Magnetic Starter.

1.2 SUBMITTALS

- A. Product Data: Submit manufacturer's data on motor starters and accessories.

1.3 COORDINATION

- A. The drawings and details there upon are scheme and/or diagrammatic in nature, and indicate the need and intent of the design. These are to be used for general guidance only. It shall be the responsibility of the Electrical Contractor to coordinate with other Division subcontractors, the installation of all motor starters, the need for control devices including the wiring and conduit, to and from the device.
- B. This coordination shall be carried out prior to actual installation. This shall be done to eliminate the possibility of conflicts between trades on items such as access, clearances and maintenance issues that may arise after completion of coordination.
- C. During the coordination phase of the project, the Electrical Contractor shall consult with Division 1 thru 23 subcontractors with regard to base design equipment characteristics. Any differences from the electrical plans and specifications shall be considered a change. The trade's contractor making the change at no additional cost to the Owner or delay in project completion shall handle these additional costs.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products of one of the following (for each type and rating of motor starter):
Allen-Bradley Co.
Cutler Hammer Products
Furnas Electric Co.
Square D Co.
Siemens

2.2 MOTOR STARTERS

- A. Provide motor starters and ancillary components; of types, sizes, ratings and electrical characteristics indicated which comply with manufacturer's standard materials, design and construction in accordance with published product information, and as required for complete installations.
- B. Fractional HP Manual Motor Starters: Provide manual, single phase, fractional HP motor starters for each motor rated less than 1/2 HP, of types, ratings and electrical characteristics indicated. Equip unit with thermal overload relay for protection of 120 volt AC motors. Provide starters with quick-make,

quick-break, trip free toggle mechanisms, selector switches for hand-off-automatic control; mount starter in NEMA Type 1 or Type 4 enclosure as indicated or required by the NEC.

- C. Magnetic Motor Starter: Provide magnetic full voltage, non-reversing starters for each motor rated 1/2 HP and more of types, ratings and electrical characteristics indicated; equip with solid state overload relays, control transformers with 120V secondary, with one secondary fuse and one grounded secondary lead, two normally open and two normally closed auxiliary contacts, hand-off-automatic selector switch, red and green pilot lights wired and mounted through front of the enclosure. Mount starter in NEMA Type 1 or Type 4 enclosure as required by the NEC.
- D. Combination Disconnect Switch Magnetic Starter: Provide full-voltage, non-reversing, combination non-fused disconnect switch and magnetic starter for each motor rated 1/2 horsepower and more, of types, ratings and electrical characteristics indicated; equip with solid state overload relays, control transformer with 120 volt secondary, one secondary fuse and one grounded secondary lead, two normally open and two normally closed auxiliary contacts, hand-off-automatic switch, red and green pilot lights wired and mounted through the front of the enclosure. Mount starter in NEMA Type 1 or Type 4 enclosure as required by the National Electrical Code (NEC).
- E. Three (3) phase, full voltage, non-reversing magnetic motor starters, horsepower rating with minimum NEMA size #0 shall be as follows:

NEMA Size	Continuous Rating	Maximum Horsepower	
		208 Volt	480 Volt
0	18 AMPs	3HP	5HP
1	27 AMPs	7-1/2HP	10HP
2	45 AMPs	10HP	25HP
3	90 AMPs	25HP	50HP
4	135 AMPs	40HP	100HP
5	270 AMPs	75HP	200HP

Motor full-load current shall not exceed continuous ampere rating of starter.

PART 3 – EXECUTION

3.1 INSTALLATION OF MOTOR STARTERS

- A. Install motor starters in accordance with manufacture's written instructions, applicable requirements of NEC, NEMA Standards, and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.
- B. The Electrical Contractor shall consult and cooperate with the Control Contractor in assisting him in making control connections to the automatic position of the selector switch and to the auxiliary contacts.
- C. Motor Data: Before installing wiring for motors and starters, the Electrical Contractor shall consult the respective parties furnishing the equipment and obtain from them all data necessary to properly connect the apparatus, and for selection of thermal overload relays in accordance with motor nameplate. Any variance in loads or electrical characteristics from the contract drawings should be reported to the Engineer before proceeding with the work.
- G. Provide connections for all motor starters as indicated on the drawings.

3.2 ADJUST AND CLEAN

- A. Inspect operating mechanisms for malfunctioning and where necessary adjust units for free

mechanical movement.

- B. Touch-up scratched or marred surfaces to match original finish.

3.3 FIELD QUALITY CONTROL

- A. Subsequent to wire/cable hookup, energize motor starters and demonstrate functioning of equipment in accordance with requirements.

END OF SECTION

SECTION 26 01 56 ADJUSTABLE FREQUENCY DRIVES

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of adjustable frequency drive (AFD) work as indicated in contract documents.
- B. Refer to other sections of this Division for Basic Materials and Methods.
- C. Types of motor controllers in this section shall include the following:
 - 1. Solid state, Pulse Width Modulation Design (PWM)
 - 2. Six-step wave form inverter.

1.2 SUBMITTALS

- A. Product Data: Submit manufacturer's data on adjustable frequency drives (AFD).
- B. Furnish a total voltage harmonic distortion calculation under worst case conditions in accordance with the procedures outlined in IEEE Standard 519-1981, based on information requested from and supplied by the Electrical Contractor to the adjustable frequency drive (AFD) supplier.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Submit in compliance with requirements and provide products of one of the following:
 - Asea Brown Boveri
 - Allen-Bradley
 - Cutler-Hammer
 - Siemens
 - Square D

2.2 ADJUSTABLE FREQUENCY DRIVE (AFD)

- A. Furnish and install a complete Adjustable Frequency Drive as described in this specification and as detailed on the applicable drawings.
- B. Installation and start-up services for the equipment shall be covered by this specification.
- C. The AFD shall be furnished by a single vendor who has actively been manufacturing AFD's for a period of at least ten (10) years.
- D. Complete drawings shall be furnished for approval before proceeding with manufacture. Drawings shall consist of a specific bill of material, connection diagrams and suitable outline drawings showing details necessary to locate conduit entrances and field wiring, including but not limited to power and control wiring as related to this project.
- E. The AFD shall comply with the latest applicable standards of ANSI, IEEE, and NEMA. As a minimum, the full load output current of the drive shall be equal to the equivalent motor horsepower as listed in the National Electrical Code Table 430-250.
- F. The AFD manufacturer shall maintain, as part of a national network, an engineering service facility within 250 miles of the project to provide start-up service, emergency service calls, repair work, service contracts, maintenance and training of customer personnel.
- G. Construction:
 - 1. The specified equipment is of the pulse width modulated (PWM) design, but the six-step wave form design shall also be acceptable. It is the intent of these specifications to match the AFD

with the motor amperage and horsepower rating in accordance with the N.E.C.

2. The AFD shall be 480 volts, 3 phase with features and options as specified.
3. The AFD shall provide a microprocessor-based adjustment of a 3 phase motor speed. The adjustable frequency and voltage output shall provide constant volts per Hertz excitation for the motor up to 60 Hertz.
4. The second step shall utilize a pulse width modulated (PWM) inverter that converts the fixed D.C. voltage to an adjustable frequency output. The inverter section shall use power transistors as switching devices.
5. Standard operating conditions shall be:
 - a. Incoming Power: 3 Phase, 480 volt, (+10% to -10%) and 60 Hertz (+/- 2 Hertz) power to a fixed potential D.C. bus level.
 - b. Humidity: 0 to 95% (non-condensing and non-corrosive)
 - c. Altitude: 0 to 3,300 feet above sea level
 - d. Ambient Temperature: 0 to 40 degrees C.
 - e. Minimum Frequency: 96% at rated load.
6. The AFD enclosure shall be NEMA 1 and shall have complete front accessibility with easily removable assemblies.
7. Enclosures shall be not less than 16-gauge steel with surfaces thoroughly cleaned and phosphatized prior to painting. Cabinet shall be primed with a corrosion resistant coating and finish painted with an ANSI 61 gray.
8. Door shall include knock-outs for mounting operator devices. Devices to be installed shall include:
 - a. A.C. line disconnect switch
 - b. Auto/manual selector switch
 - c. Start-stop pushbutton
 - d. Speed potentiometer
 - e. Ammeter 0-100 AMPs - with driver board
 - f. Frequency meter - 0 - 120 Hertz

H. Optional features to be installed:

1. External manual mechanical bypass switch, (inverter-off-bypass), with output fused to ensure short circuit protection. Switch and all required electronics and interlocks shall be prewired and housed in a NEMA 1 "Top Hat" cabinet.
2. Also installed within the "Top Hat" cabinet shall be a magnetic starter and overload protection with its own power supply. Overload heater elements shall be sized in accordance with motor nameplate rating. This starter shall include stop-start pushbuttons for control of motor while in the bypass mode.

2.3 EQUIPMENT

- A. The following equipment list is for general guidance only and does not represent a full complement of parts and materials required for a complete AFD for the project. It shall be the responsibility of the Electrical Contractor to consult and cooperate with both the AFD manufacturer and the control contractor.

1. Motors 3 Horsepower and Larger:
 - a. Adjustable Frequency Drive

- b. NEMA I Enclosure
 - c. A.C. Line Disconnect Switch
 - d. Operators
 - e. Frequency Meter
 - f. Ammeter
 - g. Meter Driver Board
 - h. 4-20 MA, 0-10 Volts D.C.
Control Signal Input.
 - i. Manual Bypass
 - j. Starter Kit
 - k. Starter Overload
- Elements - Size as required by nameplate

PART 3 – EXECUTION

3.1 INSTALLATION OF ADJUSTABLE FREQUENCY DRIVES

- A. Install adjustable frequency drives with all required options and wiring as indicated in contract documents, and in accordance with manufacturer's written instructions, applicable requirements of NEC, NEMA Standards and NECA's "Standard of Installation" and in compliance with recognized industry practices to ensure that products fulfill requirements.
- B. The AFD shall be protected against damage at all times. The drive shall be installed in a clean, dry environment with temperature and humidity within the range as specified by the drive manufacturer.
- C. The Electrical Contractor shall furnish and install all required power and control wiring and make all final connections to AFD's and bypass starters.

3.2 TESTS AND CHECKS

- A. Factory:
 - 1. All final assemblies shall be tested at full load with application of line-to-line and line-to-ground bolted faults. The AFD shall trip electronically without device failure.
 - 2. After all tests have been performed, each AFD shall undergo a 24- hour burn-in test. The drive shall be burned in at 100% inductive or motor load for 24-hours without an unscheduled shutdown.
- B. Field: Testing, checkout and start-up of the ADF equipment shall be performed under the technical direction of the manufacturer's service engineer. Under no circumstances are any portions of the drive system to be energized without authorization from the manufacturer's representative.

3.3 ADJUST AND CLEAN

- A. Inspect operating mechanisms for malfunctioning and where necessary adjust units for free mechanical movement.
- B. Touch-up scratched or marred surfaces to match original finish.

3.4 FIELD QUALITY CONTROL

- A. Subsequent to wire/cable hookup, energize AFD and demonstrate functioning of equipment in accordance with requirements.

END OF SECTION

SECTION 26 01 60 PANELBOARDS

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of panelboard load-center and enclosure work, including cabinets and cutout boxes, is indicated by drawings and schedules.
- B. Types of panelboards and enclosures in this section include the following:
Lighting and Appliance Panelboards.
Distribution Panelboards.

1.2 SUBMITTALS

- A. Product Data: Submit manufacturer's data including specifications, installation instructions and general recommendations, for each type of panelboard required. Include data substantiating that units comply with requirements.
- B. Shop Drawings: Submit dimensioned drawings of panelboards and enclosures showing layouts of enclosures and required individual panelboard devices, including by not necessarily limited to, circuit breakers, contactors, and accessories, including wiring diagrams of contactors.

1.3 COORDINATION

- A. The drawings are scheme and/or diagrammatic in nature, and indicate the need and intent of the design. These are to be used for general guidance only. It shall be the responsibility of the Electrical Contractor to coordinate, with other Division Subcontractors, the installation of all raceways, raceway supports, junction boxes and required fittings. This coordination will include conduit layout to allow access to equipment for maintenance.
- B. This coordination shall be carried out prior to actual installation; this shall be done to eliminate the possibility of conflicts between trades on items such as access, clearances and maintenance issues that may arise after completion of construction.
- C. Should the coordination not be carried out prior to installation, and a conflict exists, the installing contractor shall remove and reinstall the equipment as required to clear the conflict at no additional cost to the Owner and no delay in project completion.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products of one of the following (for each type of panelboard and enclosure):
Cutler Hammer, Inc. (Eaton)
Square D Company
Siemens

2.2 PANELBOARDS

- A. General:
 - 1. Panelboards shall comply with the following industry standards:
 - a. UL Listing/Approval
 - b. UL Standards:
 - Panelboards - UL67
 - Cabinet & Boxes - UL50

- c. National Electric Code
 - d. NEMA Standard -PBI
 - 2. Interiors:
 - a. All interiors shall be completely factory assembled. They shall be so designed that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors, so that circuits may be changed without machining, drilling and tapping.
 - b. Branch circuits shall be arranged using double row construction. A nameplate shall be provided listing panel type and rating.
 - c. Unless otherwise noted, full size insulated neutral bars shall be included. Bus bar taps for panels with single pole branches shall be arranged for sequence phasing of the branch circuit devices. Neutral bussing shall have a suitable lug for each outgoing feeder requiring a neutral connection. A ground bus will be included in all panelboards.
 - 3. Boxes: Boxes shall be a minimum 20 inches wide and manufactured from galvanized steel. Provide minimum gutter space in accordance with the National Electric Code.
 - 4. Trim:
 - a. Switching device handles shall be accessible. Panel access doors shall not uncover any live parts. Doors shall have flush type cylinder lock and catch except doors over 48" in height shall have auxiliary fastenings top and bottom of door in addition to the flush type cylinder lock and catch. Panelboard trim clamps shall be of the indicating type. Upon removal of screws behind door, the panel interiors become service accessible via piano hinged trim front.
 - b. Panel access door hinges shall be concealed. All locks shall be keyed alike; directory frame shall be welded metal and having a transparent cover shall be furnished with each door.
 - c. All exterior and interior steel surfaces of the trim shall be properly cleaned, primed with a rust inhibiting phosphatized coating and finish with a gray ANSI 61 paint. Trims for flush panels shall overlap the box for a least 3/4 inch all around. Surface trims shall have the same width and height as the box. Trims shall be mountable by a screwdriver and without the need for special tools.
 - 5. Main Bus and Branch Circuits: All main bus bars shall be full size aluminum, sized in accordance with U.L. standards to limit the temperature rise on any current carrying part to a maximum of 50 degrees C above an ambient of 40 degrees C maximum.
- B. Distribution Panelboards:
- 1. Panels shall be provided with molded case circuit breakers tested and U.L. labeled per U.L. 489.
 - 2. Circuit breakers 100 ampere through 400 ampere frame sizes shall be thermal-magnetic trip with inverse time current characteristics.
 - 3. Where multiple pole circuit breakers are indicated, provide with common trip so overload on one pole will trip all poles simultaneously. Molded case circuit breakers shall have a minimum 22,000 symmetrical RMS interrupting capacity at 240 volts.
- C. Lighting and Appliance Panelboards:
- 1. Provide switching and protective devices in quantities, ratings, types indicated, with anti-turn solderless pressure type lug connectors approved for copper conductors. Circuit breakers shall be the bolt-on, molded case, thermal magnetic type, with toggle handles that indicate when tripped. Where multiple pole circuit breakers are indicated, provide with common trip so overload on one pole will trip all poles simultaneously.

2. Panelboards for use at 240 volts AC maximum shall incorporate circuit breakers as shown rated at 10,000 A.I.C. symmetrical at 240 volts.
3. Panelboards for use at 480/277 volts AC maximum shall incorporate circuit breakers as shown rated at 14,000 A.I.C. symmetrical at 480 volts.

PART 3 – EXECUTION

3.1 INSTALLATION OF PANELBOARDS

- A. Install panelboards and enclosures where indicated in contract documents and, in accordance with the equipment manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.
- B. Anchor enclosures firmly to walls and structural surfaces, ensuring that they are permanently and mechanically secure.
- C. Provide all required electrical and grounding connections within the panelboards and enclosures.
- D. The Electrical Contractor shall furnish and install on the door within each enclosure, a circuit labeling identification system for all electrical panelboards. The system must satisfy the NEC Article No. 110-22. The directories shall be typed, NOT handwritten. Directories shall indicate room numbers as indicated on contract documents and room numbers as physically labeled in the field.
- E. The Electrical Contractor shall provide directories compiled using a software program that is Windows compatible. Program shall handle multiple panels, calculate panel electrical loads from user supplied data, maintain a history of repairs and upgrades by circuit, and be capable of printing panel directories and summaries. Verify compatibility with Owner's operating system.
- F. Provide two discs to owner containing software and project panel directories and summaries.

END OF SECTION 26 0160

**SECTION 26 01 65
SWITCHBOARDS****PART 1 – GENERAL****1.1 DESCRIPTION OF WORK**

- A. Extent of switchgear and switchboards is indicated by drawings and schedules.
- B. Types of switchgear and switchboards in this section include the following:
Dead-Front Switchboards.

1.2 SUBMITTALS

- A. Product Data: Submit manufacturer's data on switchgear and switchboards.
- B. Shop Drawings: Submit dimensioned drawings of switchgear and switchboards showing accurately scaled basic sections including, but not necessarily limited to, auxiliary compartments, section components, and combination sections.

1.3 COORDINATION

- A. The drawings are scheme and/or diagrammatic in nature, and indicate the need and intent of the design. These are to be used for general guidance only. It shall be the responsibility of the Electrical Contractor to coordinate, with other Division Subcontractors, the installation of housekeeping equipment pad, switchboard cabinet structures, feeders, branch circuits, switchboard hardware and required fittings. This coordination will include conduit layout to allow access to equipment for maintenance.
- B. This coordination shall be carried out prior to actual installation; this shall be done to eliminate the possibility of conflicts between trades on items such as access, clearances and maintenance issues that may arise after completion of construction.
- C. Should the coordination not be carried out prior to installation, and a conflict exists, the installing contractor shall remove and reinstall the equipment as required to clear the conflict at no additional cost to the Owner and no delay in project completion.

PART 2 – PRODUCTS**2.1 ACCEPTABLE MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products of one of the following:
Dead-Front Switchboards
Cutler Hammer, Inc. (Eaton)
Square D Co.
Siemens

2.2 EQUIPMENT AND COMPONENTS

- A. Furnish the service entrance switchboard as indicated in contract documents. The switchboard shall meet the latest requirements of Underwriters Laboratories' Standard No. 891, NEMA PB2 and the National Electric Code. The switchboard shall be furnished with an Underwriters Laboratories' label.
- B. Enclosure Construction: The switchboard shall be deadfront with front accessibility required. The switchboard frame shall be of formed code gauge steel rigidly welded and bolted together to support all coverplates, bussing and component devices during shipment and installation. Steel base channels shall be bolted to the frame to rigidly support the entire shipping section for moving on rollers and floor mounting. Each switchboard section shall have an open bottom and an individually removable top plate for installation and termination of conduits. The switchboard enclosure shall be painted on all exterior and interior surfaces. The paint finish shall be a medium light gray, ANSI #49, applied by

the electro-deposition process over an iron phosphate pre-treatment. All front covers shall be screwed on and removable and all doors shall be hinged with removable hinge pins. Top and bottom conduit areas shall be clearly indicated on shop drawings.

- C. Bussing: The switchboard bussing shall be of a sufficient cross-sectional area to meet U.L. Standard 891 temperature rise. Through bus shall be extruded aluminum plated by the Alstan 70 process. The through bus shall have an ampacity where indicated on the single line riser diagram and shall be rated to withstand a short circuit current rating of 50,000 RMS symmetrical amperes. The through bus supports, connections and joints are to be bolted with hex-head bolts and belleville washers to minimize maintenance requirements and shall have provisions for the addition of future sections.
- D. Short Circuit Current Rating: Each switchboard, as a complete unit, shall be given a single short circuit current rating by the manufacturer in accordance with U.L. specifications, on equipment constructed similarly to the subject switchboard.
- E. Main Circuit Breaker: The service disconnect device shall be a molded case circuit breaker totally front accessible and front connectable. The circuit breaker shall be provided with ground fault protection.
- F. Branch Circuit Breakers: Group mounted molded case circuit breakers shall be totally front accessible. The circuit breakers shall be mounted in the switchboard to permit installation, maintenance and testing without reaching over any line side bussing. The circuit breakers are to be removable by the disconnection of only the load side cable terminations and all line and load side connections are to be individual to each circuit breaker. No common mounting brackets or electrical bus connectors will be acceptable.
- G. Main switchgear shall be furnished with a phase loss relay with a set of contacts to send a trouble alarm to security control panel. Unit shall be furnished, installed and wired by equipment manufacturer. All other wiring required for proper interface to security control panel shall be by the Electrical Contractor. Coordinate all work and provide all required wiring as directed by Owner's local security system representative. Relay shall be of type Taylor Phase Guard, model PND, with (adj.) Phase Loss Time Delay Adjustment, or approved substitute.

PART 3 – EXECUTION

3.1 INSTALLATION OF SWITCHGEAR AND SWITCHBOARDS

- A. Install switchgear and switchboards where shown, in accordance with manufacturer's written instructions, with recognized industry practices to ensure that switchgear and switchboards comply with requirements of NEMA and NEC Standards, and applicable portions of NECA's "Standard of Installation".
- B. Tighten electrical bus connections and mechanical fasteners.
- C. Provide connections within switchboard.

3.2 ADJUST AND CLEAN

- A. Adjust operating mechanisms for free mechanical movement.
- B. Touch-up scratched or marred surfaces to match original finish.

3.3 FIELD QUALITY CONTROL

- A. Prior to energization of switchboards, check with ground resistance tester phase-to-phase and phase-to-ground insulation resistance levels to ensure requirements are fulfilled.
- B. Prior to energization, check switchboards for electrical continuity of circuits, and for short circuits.
- C. Subsequent to wire and cable hook-ups, energize switchboards and demonstrate functioning in accordance with requirements.

END OF SECTION

SECTION 26 01 70
MOTOR AND CIRCUIT DISCONNECTS

PART 1 – GENERAL**1.1 DESCRIPTION OF WORK**

- A. Extent of motor and circuit disconnect switch work is indicated by drawings and schedules.
- B. Types of motor and circuit disconnect switches in this section include the following:
 - Equipment disconnects.
 - Appliance disconnects.
 - Motor-circuit disconnects.

1.2 SUBMITTALS

- A. Product Data: Submit manufacturer's data including specifications, installation instructions and general recommendations, for each type of motor and circuit disconnect switch required.

1.3 COORDINATION

- A. The drawings are scheme and/or diagrammatic in nature, and indicate the need and intent of the design. These are to be used for general guidance only. It shall be the responsibility of the Electrical Contractor to coordinate, with other Division Subcontractors, the installation of all motor and circuit disconnect switches, supporting hardware, including wiring and conduit, to and from the equipment. This coordination will include conduit layout to allow access to equipment for maintenance.
- B. This coordination shall be carried out prior to actual installation; this shall be done to eliminate the possibility of conflicts between trades on items such as access, clearances and maintenance issues that may arise after completion of construction.
- C. Should the coordination not be carried out prior to installation, and a conflict exists, the installing contractor shall remove and reinstall the equipment as required to clear the conflict at no additional cost to the Owner and no delay in project completion.

PART 2 – PRODUCTS**2.1 ACCEPTABLE MANUFACTURERS**

- A. Manufacturer: Subject to compliance with requirements, provide products of one of the following (for each type of switch):
 - Cutler-Hammer, Inc. (Eaton)
 - Square D Company
 - Siemens

2.2 FABRICATED SWITCHES

- A. Safety Switches: Safety switches shall be of sizes noted on the drawings, fusible or non-fusible and contained in a general purpose enclosure. All switches shall be type HD and have quick-make, quick-break operation. All switches shall be of proper horsepower rating as applicable and have dual interlocks designed to interlock the switch box door with the switch operating mechanism. Unit shall be provided with a suitable means of interlock release. An arrangement shall be provided for locking the operating handle in the "ON" or "OFF" position. Safety switches shall have the proper type metal enclosure, i.e., standard, weatherproof, etc., to suit their specific location as required by the National Electrical Code.
- B. Fuses: Provide fuses for safety switches, as recommended by switch manufacturer, of classes, types and ratings needed to fulfill electrical requirements for service indicated.
- C. Provide connections for all disconnect switches as indicated on the drawings.

PART 3 – EXECUTION

3.1 INSTALLATION OF MOTOR AND CIRCUIT DISCONNECT SWITCHES

- A. Install motor and circuit disconnect switches where indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA, and NECA's "Standard of Installation", and in accordance with recognized industry practices to ensure that products fulfill requirements.
- B. Install disconnect switches used with motor-driven appliances, and motors and controllers within sight of controller position unless otherwise indicated.
- C. Provide electrical connections for motor and circuit disconnect switches.

END OF SECTION

SECTION 26 01 80 OVERCURRENT PROTECTIVE DEVICES

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of overcurrent protective device work is indicated by drawing schedules and specifications.
- B. Types of overcurrent protective devices in this section include the following:
 - 1. Service entrance rated disconnect.
 - 2. Molded case circuit breaker.

1.2 SUBMITTALS

- A. Product Data: Submit manufacturer's data on overcurrent protective devices, including: voltages and current ratings, interrupting ratings, current limitations, internal inductive and non-inductive loads, time-current trip characteristic curves, and mounting requirements.
- B. Shop Drawings: Submit layout drawings of overcurrent protective devices, showing spatial relationships of units to associated electrical equipment, and connections to electrical power supplies.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include the following:
 - 1. Circuit-Breakers
 - Cutler-Hammer, Inc. (Eaton)
 - Square D Co.
 - Siemens

2.2 CIRCUIT BREAKERS

- A. Except as otherwise indicated, provide circuit breakers and ancillary components, of types, sizes, ratings and electrical characteristics indicated, which comply with manufacturer's standard design, materials, components, and construction in accordance with published product information, as required for a complete installation.
- B. Service Entrance Rated Disconnect: The service disconnect device shall be a molded-case circuit breaker totally front accessible and front connectable. The circuit breaker shall be a three pole device suitable for operation on a 480 volt, 60 Hertz system. Circuit breaker shall have 65,000 RMS symmetrical amperes interrupting rating, and shall be UL approved for Service Entrance equipment.
- C. Molded-Case Circuit Breakers: Provide factory assembled, molded-cased circuit breakers of frame size indicated; 120/208 volts, and 277/480 volts 60 Hertz, one, two, or three poles with a short circuit symmetrical ampere interrupting rating as indicated by the panel schedule and/or as shown by the single line riser diagram. Provide circuit breakers with permanent thermal instantaneous magnetic trips in each pole with ampere ratings as indicated. Construct with overcenter, trip-free, toggle type operating mechanisms with quick-make, quick-break action and positive handle trip indication. Construct devices for mounting and operating in any physical position and operating in an ambient temperature of 40 degrees C. Provide circuit breakers with

mechanical screw type connector lugs, AL/CU rated.

PART 3 – EXECUTION

3.1 INSTALLATION OF OVERCURRENT PROTECTIVE DEVICES

- A. Install overcurrent protective devices as indicated in contract documents, in accordance with the manufacturer's written instructions and with recognized industry practices to ensure that protective devices comply with requirements. Comply with NEC Standards for Installation of overcurrent protective devices.
- B. Coordinate with other work, including electrical wiring work, as necessary to interface installation of overcurrent protective devices with other work.
- C. Fasten circuit breakers without causing mechanical stresses, twisting or misalignment being exerted by clamps, supports, or cabling.

3.2 ADJUST AND CLEAN

- A. Inspect circuit-breaker operating mechanisms for malfunctioning and, where necessary, adjust units for free mechanical movement.

3.3 FIELD QUALITY CONTROL

- A. Prior to energization of overcurrent protective devices, test devices for continuity of circuitry and for short-circuits. Correct malfunctioning units, and then demonstrate compliance with requirements.

END OF SECTION

SECTION 26 01 90 SUPPORTING DEVICES

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK

- A. Types of supports, anchors, sleeves and seals specified in this section include the following:
 - Hangers.
 - Riser Clamps.
 - C-clamps
 - I-beam clamps.
 - One-hole conduit straps.
 - Two-hole conduit straps.
 - Round steel rods.
 - Lead expansion anchors.
 - Toggle bolts.
 - U-Channel Strut Systems.

PART 2 – PRODUCTS

2.1 MANUFACTURED SUPPORTING DEVICES

- A. Provide supporting devices, complying with manufacturer's standard materials, design and construct in accordance with published product information, and as required for a complete installation, and as herein specified.
- B. Supports: Provide supporting devices of types, sizes and materials having the following construction features:
 - Hangers: For supporting EMT conduit, electro-galvanized steel, with 1/4" minimum diameter hole for round steel rod; approximately MSS types 5, 7, 9 or spring steel conduit clips.
 - Reducing Couplings: Steel rod reducing coupling, 1/4" minimum black steel.
 - C-Clamps: Black malleable iron, 1/4" minimum rod size.
 - I-Beam Clamps: Black steel, 1-1/4" x 3/16" stock; 3/8" cross bolt; flange width 2"; approx. 52 pounds per 100 units.
 - One-Hole Conduit Straps: For supporting EMT conduit, electro- galvanized steel.
 - Two-Hole Conduit Straps: For supporting EMT conduit, electro-galvanized steel; 3/4" strap width; and 2-1/8" between center of screw holes.
 - Hexagon Nuts: For 1/4" rod size; galvanized steel.
 - Round Steel Rod: Black steel; 1/4" min. dia.
 - Offset Conduit Clamps: For supporting rigid metal conduit; black steel.
- C. Anchors: Provide anchors of types, sizes and materials indicated; and having the following construction features:
 - Lead Expansion Anchors: 1/4" - 20 Minimum.
 - Toggle Bolts: Springhead; 3/16 x 4".
- D. Manufacturer: Subject to compliance with requirements, provide anchors of the following:
 - Ackerman Johnson Fastening Systems, Inc.

Elcen Metal Products Co.

Ideal Industries, Inc.

Rawlplug Co., Inc.

Star Expansion Co.

U.S. Expansion Bolt Co.

Erico Products, Inc. (Caddy)

Hilti, Inc.

- E. U-Channel Strut Systems: Provide U-channel strut system for supporting electrical equipment, 16-gauge hot dip galvanized steel, construct with 9/16" dia. holes, 8" o.c. on top surface, with standard hot dip galvanized finish, and with the following fittings which mate and match with U-channel.

Beam clamps.

Thinwall conduit clamps.

Conduit hangers.

U-bolts.

- F. Manufacturers: Subject to compliance with requirements, provide channel systems of one of the following:

B-Line Systems, Inc.

Elcen Metal Products Co.

Power-Strut Div.; Van Huffer Tube Corp.

Unistrut Div.; GTE Products Corp.

Hilti, Inc.

PART 3 – EXECUTION

3.1 INSTALLATION OF SUPPORTING DEVICES

- A. Install hangers and anchors in accordance with manufacturer's written instructions and with recognized industry practices to ensure supporting devices comply with requirements. Comply with requirements of NECA, NEC and ANSI/NEMA for installation of supporting devices.
- B. Install hangers, supports, clamps and attachments to support piping properly from building structure. Arrange for grouping of parallel runs of horizontal conduits to be supported together on trapeze type hangers where possible. Install supports with maximum spacings.

END OF SECTION

SECTION 26 01 95 POWER SYSTEM STUDIES

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK

A. Short Circuit Coordination Study:

1. Short circuit studies, protective device evaluation studies and protective device coordination studies shall be performed by the switchboard manufacturer. The studies shall be submitted to the Engineer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment for manufacture.
2. The studies shall include all portions of the electrical distribution system from the utility service equipment to all downstream distribution and branch panelboards, including normal and emergency equipment.

B. Arc Fault Calculations and Labeling:

1. Complete arc fault available current calculations and labeling shall be provided by the Electrical Contractor. Calculations may be performed by a subcontractor such as the switchboard manufacturer. Calculations shall be submitted to the Engineer prior to manufacture of labels, for review and approval.
2. Calculations shall include all portions of the electrical distribution system from the utility service equipment to all downstream distribution and branch panelboards; and from generator to all emergency distribution and transfer switches.
3. Electrical Contractor shall provide permanent labels on all electrical distribution system equipment as listed above. Labels shall indicate maximum available arc fault current per NEC 2011, Article 110. In addition, labels shall indicate level of personal protective equipment appropriate for the hazard, as defined in NFPA 70E.

PART 2 – DATA ACQUISITION

2.1 DATA COLLECTION FOR THE STUDIES

- A. The Contractor shall provide the required data for preparation of the studies. The switchboard manufacturer shall furnish the contractor with a listing of the required data immediately after award of the contract.
- B. The Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to release of the equipment for manufacture.
- C. The Contractor shall be responsible for provision of all feeder lengths required for all calculations.

2.2 SHORT CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY

- A. The short circuit study shall be performed with the aid of a digital computer program and shall be in accordance with ANSI C37.5-1969 (R1975), IEEE Std. 320-172 and IEEE Std. 141-1976.
- B. The study input data shall include the Power Company's short circuit contribution, resistance and reactance components of the branch impedances, the X/R ratios, base quantities selected, and other source impedances. This data shall be obtained by the contractor from the Utility Company.
- C. Short circuit close and latch duty values and interrupting duty values shall be calculated on the basis of assumed three-phase bolted short circuits at each switchgear bus, medium voltage controller, switchboard, low voltage motor control center, distribution panelboard, pertinent branch circuit panel and other significant locations through the system. The short circuit tabulations shall include symmetrical fault currents and X/R ratios. For each fault location, the total duty on the bus, as well

as the individual contribution from each connected branch, shall be listed with its respective X/R ratio.

- D. A protective device evaluation of circuit breakers, disconnect switches, and fuses by tabulating and comparing the short circuit ratings of these devices with the calculated fault currents. Appropriate multiplying factors based on system X/R ratios and protective device rating standards shall be applied. Any problem areas or inadequacies in the equipment due to short circuit currents shall be promptly brought to the Engineer's attention.

2.3 PROTECTIVE DEVICE COORDINATION STUDY

- A. A protective device coordination study shall be performed to provide the necessary calculations and logic decisions required to select the protective relay characteristics and settings, ratios and characteristics of associated current transformers, and low voltage breaker trip characteristics and settings.
- B. The coordination study shall include all medium and low voltage classes of equipment from the building service protective devices down to and including the largest rated device in the MCC low voltage motor control center and panelboard. The phase and ground overcurrent protection shall be included as well as settings of all other adjustable protective devices.
- C. The time-current characteristics of the specified protective devices shall be drawn on Keuffel and Esser Log - log paper. The plots shall include complete titles, representative one-line diagram and legends, significant motor starting characteristics, complete parameters of transformers, complete operating bands of low voltage circuit breaker trip curves and fuses. The coordination plots shall indicate the types of protective devices selected, proposed relay taps, time dial and instantaneous trip settings, transformer magnetizing inrush and ANSI transformer withstand parameters, cable thermal overcurrent withstand limits and significant symmetrical and asymmetrical fault currents. All restrictions of the National Electrical Code shall be adhered to and proper coordination intervals and separation of characteristic curves shall be maintained. The coordination plots for phase and ground protection devices shall be provided on a system basis. A sufficient number of separate curves shall be used to clearly indicate the coordination achieved.
- D. The selection and settings of the protective devices shall be provided separately in a tabulated form listing circuit identification, IEEE device number, current transformer ratios and connection, manufacturer and type, range of adjustment and recommended settings. Any discrepancies, problem areas, or inadequacies shall be promptly brought to the Engineer's attention.

2.4 STUDY REPORT

- A. The results of the Power System Study shall be summarized in a final report. Submit six (6) bound copies of final report.
- B. The report shall include the following sections:
 - 1. Description, purpose, basis and scope of the study and a single line diagram of that portion of the power system which is included within the scope of the study.
 - 2. Tabulations of circuit breakers, and other protective device ratings versus calculated short circuit duties, and commentary regarding same.
 - 3. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip settings, and commentary regarding same.
 - 4. Fault current calculations including a definition of terms and guide for interpretation of computer printout.

PART 3 – EXECUTION

3.1 PROTECTIVE DEVICE TESTING, CALIBRATION AND ADJUSTMENT

- A. The equipment manufacturer shall provide the services of a qualified field Engineer any necessary

tools and equipment to test, calibrate and adjust the protective relays and circuit breaker trip devices as recommended in the Power System Study.

3.2 ARC FAULT LABELING

- A. Contractor shall submit sample of arc fault label during shop drawing review for approval.

END OF SECTION

SECTION 26 04 30
METERING EQUIPMENT**PART 1 – GENERAL****1.1 DESCRIPTION OF WORK**

- A. The extent of circuit monitoring equipment work is indicated by drawings and schedules. Circuit monitoring equipment is defined as a single discrete unit attached to the Electrical Distribution System which is intended to furnish read-outs of electrical energy consumption.
- B. Types of electrical circuit monitoring equipment in this section include the following:
Digital Circuit Monitoring Package.

1.2 SUBMITTALS

- A. Product Data: Submit manufacturer's data on a complete digital metering package, including but not limited to, wiring diagrams.

PART 2 – PRODUCTS**2.1 ACCEPTABLE MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products of one of the following:
Square D Company: Powerlogic.
Westinghouse Electric Corporation: IQ Data
Siemens

2.2 EQUIPMENT

- A. Furnish in a surface mounted, general purpose, NEMA 1 enclosure, a microprocessor based digital circuit monitoring package complete with required current transformers sized to match main circuit breaker rating.
- B. Unit shall provide the following direct reading metered values:
 - 1. A.C. Amperes: 1% Accuracy, Phase A, Phase B, Phase C.
 - 2. A.C. Voltage: 1% Accuracy, Phase A-B, Phase B-C, Phase C-A
Phase A-N, Phase B-N, Phase C-N
 - 3. Watts: 2% Accuracy.
 - 4. Vars: 2% Accuracy.
 - 5. Power Factor: 4% Accuracy.
 - 6. Frequency: 0.5% Accuracy.
 - 7. Watt Demand: 2% Accuracy.
 - 8. Watthours: 2% Accuracy.
 - 9. Temperature: 2% Accuracy.
- C. Unit shall retain the peak demand value and shall automatically reset when the building sets a new peak demand value.

PART 3 – EXECUTION**3.1 INSTALLATION OF METERING EQUIPMENT**

- A. Install circuit monitoring equipment devices in accordance with the manufacturer's written instructions and with recognized industry practices to ensure that the metering equipment complies with the requirements of the project.

3.2 ADJUST AND CLEAN

- A. Inspect circuit monitoring equipment for malfunctioning and, where necessary, adjust equipment.

3.3 FIELD QUALITY CONTROL

- A. Prior to energization of the circuit monitoring equipment, test equipment for continuity of circuitry and for short-circuits. Adjust or correct malfunctioning equipment, and then demonstrate compliance with project requirements.

END OF SECTION

SECTION 26 04 44**PAD-MOUNTED PRIMARY LOAD INTERRUPTER****PART 1 – GENERAL****1.1 DESCRIPTION OF WORK**

- A. The extent of high-voltage metal enclosed switchgear work is indicated by drawings and specifications.
- B. The metal enclosed switchgear shall conform to the following specifications.

1.2 SUBMITTALS

- A. The manufacturer shall furnish with each metal enclosed switchgear assembly, a set of drawings complete with a bill of material and showing typical front views and open side views for each compartment as well as for typical components, their positions, and available space for cable terminations; an anchor bolt plan with dimensions; a one-line diagram; and appropriate wiring diagrams.
- B. The manufacturer shall furnish a comprehensive instruction manual covering installation of the switchgear assembly and operation of the various components.

1.3 METAL-ENCLOSED SWITCHGEAR ASSEMBLY

- A. The metal enclosed switchgear assembly shall consist of four (4) outdoor compartments, containing interrupter switches and power fuses, with the necessary components, all completely factory assembled and operationally checked.
- B. The metal-enclosed switchgear shall be S&C Electric Company's source-transfer Model No. PMH Series. Unit shall provide fully automatic primary selective service and fault protection for one (1) critical load circuit on a solidly grounded system. The unit shall contain, but not be limited to the following:
 - 1. Stored-energy switch-operator-driven 600 ampere S&C Mini-Rupter switches for three-pole live switching of three phase source circuits.
 - 2. A totally self-contained automatic source-transfer package with S&C voltage sensors for sensing and control power, and S&C Micro-AT source-transfer control for programmed control of all switching functions associated with automatic source transfer.
 - 3. Decouplers to permit exercising of the switch operators without affecting the positions of the switches.
 - 4. 400 ampere hook stick operated S&C power fuses with Uni-Rupter for single-pole live switching of three phase load circuits. The power fuse mountings shall accommodate the current-limiting fuses indicated on the drawings.

1.4 RATINGS

- A. The site distribution system will be 14,400/24,940 KV grounded.
- B. The ratings for the integrated switchgear assembly shall be as designated below:
 - KV, Nominal- 25
 - KV, Maximum - 29
 - KV, BIL - 125
 - Main Bus Continuous, Ampere-600
 - Short Circuit Ratings:
 - Amperes, RMS Symmetrical - 12,500

MVA Three-phase Symmetrical at Rated Nominal

Voltage - 500

Duty-Cycle Fault-Closing Amperes, RMS Asymmetrical - 13,000

1.5 CERTIFICATION OF RATINGS

- A. The manufacturer of the metal-enclosed switchgear shall be completely and solely responsible for the performance of the basic switch and fuse components as well as the complete integrated assembly as rated.
- B. The manufacturer shall furnish, upon request, certification of ratings of the basic switch and fuse components and/or the integrated metal-enclosed switchgear assembly consisting of the switch and fuse components in combination with the outdoor enclosure.
- C. The integrated switchgear assembly shall have a BIL rating established by test on switchgear of the type and kind to be furnished under this specification. Certified test abstracts establishing such ratings shall be furnished upon request.

1.6 COMPLIANCE WITH STANDARDS & CODES

- A. The metal-enclosed switchgear shall conform to or exceed the applicable requirements of the following standards and codes:
 - 1. ANSI C57.12.28 (enclosure integrity)
 - 2. The applicable portions of Article 710 in the National Electrical Code, including Article 710-21(e), which specifies that the interrupter switches in combination with power fuses shall safely withstand the effects of closing, carrying, and interrupting all possible currents up to the assigned maximum short-circuit rating.

PART 2 – CONSTRUCTION

2.1 COORDINATION

- A. To ensure a completely coordinated design, the metal-enclosed switchgear shall be constructed in accordance with the minimum construction specifications of the fuse and/or switch manufacturer to provide adequate electrical clearances and adequate space for fuse handling and switch operation.

2.2 ENCLOSURE CONSTRUCTION

- A. The enclosure shall be a pad-mounted, outdoor, free-standing, self-supporting construction with provisions for cable entrance and exit through the bottom.
- B. The enclosure roof shall be undercoated with an insulating "no-drip" compound. A resilient closed-cell gasket on the enclosure bottom flange shall protect the finish from being scratched during installation and shall isolate it from the alkalinity of the concrete foundation.
- C. The enclosure shall be provided with a 18" base spacer compartment for increase cable termination height. The enclosure and base spacer shall be protected from corrosion by S&C's olive green Ultradur finishing system.
- D. The switch manufacturer shall furnish and install in each compartment a space heater sized as required, with all required wiring and controls. A control power transformer shall be provided with all primary and secondary protection and sized to support space heaters.

2.3 SOURCE-TRANSFER CONTROL

- A. The source-transfer controls shall utilize an advanced electronic microprocessor to perform control operations, as directed by the settings programmed into the device at the factory.
- B. The source-transfer control shall continuously monitor the condition of both primary sources and, when the preferred-source voltage is lost (or reduced to a predetermined level) initiates switching in accordance with the settings to automatically restore power to the building served by the pad-

mounted gear.

- C. The source-transfer control shall contain all the standard features as provided by S&C Electric Company. Factory programming shall provide for open-transition (non-paralleling) automatic retransfer.

PART 3 – EXECUTION

3.1 INSTALLATION OF PAD-MOUNTED LOAD INTERRUPTERS

- A. Install the primary, pad-mounted, load interrupter switchgear as indicated in contract documents, and in accordance with equipment manufacturer's written instructions and complying with applicable portions of NEC and NECA's "Standard of Installation".
- B. Anchor switchgear enclosures firmly to equipment pad, ensuring that they are permanently and mechanically secure. Contractor shall seal around base of equipment to keep water from flowing across pad below switchgear. All conduits to be finished off one (1) inch above equipment pad to block any water from entering ducts.
- C. Provide all electrical connections within the switchgear enclosures, including all grounding indicated on the plans and/or as required by NEC weather indicated on the plans or not.

3.2 FIELD QUALITY CONTROL

- A. Inspect relays and control equipment for malfunction, and where necessary, adjust equipment for proper operation to fulfill project requirements.
- B. The Electrical Contractor shall retain the services of S&C Electric Company to assure that all equipment is functioning in accordance with project requirements. The Electrical Contractor and S&C Electric Company shall demonstrate, the OWNER and the Engineer that the equipment functions and will not permit the two (2) services to be paralleled under any condition.
- C. Final adjustment, equipment startup, operation and maintenance instructions for the Owner's personnel shall be performed by specially trained personnel in the direct employ of the S&C Electric Company.

END OF SECTION

SECTION 26 04 52 GROUNDING

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK

- A. Types of grounding in this section include the following:

Grounding:

Underground metal piping.

Underground metal water piping.

Grounding rods.

Service equipment.

Enclosures.

Systems.

Equipment.

Building Structural Steel (Bonding)

PART 2 – PRODUCTS

2.1 GROUNDING

- A. Except as otherwise indicated, provide each electrical grounding system indicated, with assembly of materials including, but not necessarily limited to, cables/wires, connectors, terminals (solderless lugs), and other items and accessories needed for complete installation. Where materials or components are not otherwise indicated, comply with NEC, NEMA, and established industry standards for applications indicated.

- B. Provide conduit, tube, duct, cable and fittings complying with Division 26 Basic Materials and Methods section, "Raceways", in accordance with the following listing:

Rigid steel conduit.

Electrical metallic tubing.

Flexible metal conduit.

Liquid-tight flexible metal conduit.

Rigid metal conduit fittings.

EMT fittings.

Flexible metal conduit fittings.

Liquid-tight flexible metal conduit fittings.

Manufactured Cabling Systems

2.2 ELECTRICAL GROUNDING CONDUCTORS

- A. Unless otherwise indicated, furnish a green insulated equipment grounding conductor for all feeders and branch circuits, matching power supply wiring materials and sized according to NEC.

2.3 BONDING PLATES, CONNECTIONS, TERMINALS & CLAMPS

- A. Provide electrical bonding plates, connectors, terminals and clamps as recommended by bonding plate, connector, terminal and clamp manufacturers for applications.

2.4 GROUND RODS & PLATES

- A. Ground Rods: Steel with copper welded exterior, 3/4" dia. x 10'.

PART 3 – EXECUTION

3.1 INSTALLATION OF GROUNDING SYSTEMS

- A. Install electrical grounding systems in accordance with manufacturer's written instructions and with recognized industry practices to ensure grounding complies with requirements. Comply with requirements of NEC, NESC, NEMA and UL standards for installation of grounding systems.
- B. Coordinate with other electrical work as necessary to interface installation of grounding system with other work.
- C. Clamp cable connections to ground rods.
- D. Install bonding jumpers with ground clamps on water meter piping to electrically bypass water meter.
- E. Install clamp-on connectors only on thoroughly cleaned metal contact surfaces, to ensure electrical conductivity and circuit integrity.

3.2 FIELD QUALITY CONTROL

- A. Upon completion of installation of electrical grounding system, test ground resistance with ground resistance tester. Where tests show resistance-to-ground is over 25 ohms, take appropriate action to reduce resistance to 25 ohms or less by driving additional ground rods and/or by chemically treating soil encircling ground rods with sodium chloride, calcium chloride, copper sulphate, or magnesium. Then retest to demonstrate compliance.

END OF SECTION

SECTION 26 04 60 TRANSFORMERS

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of transformer work is indicated by drawings and schedules.
- B. Types of transformers in this section include the following:
Dry type transformers (Energy Star NEMA TP-1 compliant)
Pad-mounted, oil-filled transformers

1.2 SUBMITTALS

- A. Product Data: Submit manufacturer's data on power/distribution transformers, including certification of transformer performance efficiency at indicated loads, percentage regulation at 100% and 80% power factor, no-load and full-load losses in watts, % impedance at 75 Degrees C, hot-spot and average temperature rise above 40 degrees C ambient, sound level in decibels and standard published data including dimensions and net and shipping weights.
- B. Shop Drawings: Submit dimensioned drawings of transformer installations, showing mountings and supports.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products of one of the following (for each type of transformer):
Dry
General Electric
Sorgel Electric Division/Square D Company
Cutler-Hammer/Eaton Electrical, Inc.
The ABB Group
Siemens Energy & Automation, Inc.
Mirus International, Inc.
Approved Substitute

2.2 POWER/DISTRIBUTION TRANSFORMERS

- A. Except as otherwise indicated, provide manufacturer's standard materials and components as indicated by published product information designed and constructed as recommended by manufacturer, and as required for complete installation.
- B. Three Phase Distribution Transformers: Provide open ventilated dry- type three phase distribution transformers, 480-volt delta primary, 120/208-volt secondary with KVA rating as indicated on the drawings. Transformers shall have 220°C Class insulation and temperature rise rating of 150 degrees C. Unit shall be provided with four approximately 2-1/2% taps, two above and two below rated primary voltage. A low voltage neutral terminal shall be provided. Coils shall be enclosed by a sheet steel enclosure comprised of readily removable sections having ventilated openings in front cover. Core and coil assemblies shall be mounted on rubber isolation pads. Limit terminal compartment to 75 degrees C. at full-rated load. Provide wiring connectors suitable for copper wiring. Cushion-mount transformers with external vibration isolation supports. Electrically ground core and coils to transformer enclosure by means of flexible metal grounding strap.

2.3 HARMONIC MITIGATING ISOLATION TRANSFORMERS: (T-3)

- A. Furnish an isolation transformer with low zero sequence output impedance designed to reduce the voltage distortion created by the 3rd and other triplen harmonic currents. Primary-secondary phase shift permits cancellation of 5th, 7th, 17th and 19th harmonic currents with those of other loads fed from the same primary supply. Transformer shall be Energy Star rated and be compliant with NEMA Standard TP-1.
- B. Furnish an open ventilated, three (3) phase, common core unit with copper windings. Unit voltage and KVA rating shall be as indicated on the floor plans and/or single line diagram. Transformers shall have a insulation class 220 degrees C. and a temperature rise rating of 80 degrees C. Unit shall be furnished with a full load efficiency of 97% minimum at 170 degrees C. and two (2) full load taps above normal and two (2) full load taps below normal. Transformer shall have single electrostatic shielding rated 60dB attenuation.
- C. Enclosure shall be an open ventilated, NEMA-1, general purpose, finished in grey with anti-vibration pads between the core and the enclosure.
- D. Transformer shall be similar to Mirus International, Inc., Model Harmony-1, 2 or 3, based on the quantity of feeder taps or approved equal.

PART 3 – EXECUTION

3.1 INSTALLATION OF TRANSFORMERS

- A. Install transformers as indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA and IEEE Standards, and in accordance with recognized industry practices to ensure that products fulfill requirements.
- B. Install units on vibration mounts; comply with manufacturer's installation method if any.

3.2 GROUNDING

- A. Provide tightly fastened equipment grounding and bonding connections for transformers.

3.3 TESTING

- A. Upon completion of installation of transformers, energize primary circuit at rated voltage and frequency from normal power source and test transformers, including, but not limited to, audible sound levels, to demonstrate capability and compliance with requirements. Where possible, correct malfunction units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new units and proceed with retesting.

END OF SECTION

SECTION 26 04 70 DISTRIBUTION CIRCUITS

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK

- A. Distribution circuit work is indicated by drawings and schedules.
- B. The distribution circuits shall include furnishing and installing a complete wire and conduit system between distribution panelboards and branch circuit panelboards.
- C. Types of equipment to be furnished and installed in this section include the following:
 - Rigid Metal Conduit
 - Intermediate Metal Conduit (IMC)
 - Electrical Metallic Tubing (EMT)
 - PVC (Below Slab Only)
 - Wires and Cables
 - Junction Boxes
 - Pull Boxes
 - Conduit Bodies
 - Bushings
 - Locknuts
 - Supporting Devices

PART 2 – PRODUCTS

2.1 DISTRIBUTION CIRCUITS

- A. Furnish and install each distribution circuit indicated, with assembly of materials, including but not necessarily limited to, conduit, wire, pull boxes, junction boxes and other items and accessories needed for a complete installation. Where materials or components are not otherwise indicated, comply with NEC, NEMA and established industry standards for applications indicated.

PART 3 – EXECUTION

3.1 INSTALLATION OF DISTRIBUTION CIRCUITS

- A. Install distribution circuits complying with equipment manufacturer's written instructions, applicable requirements of NEC, NEMA, and NECA's "Standard of Installation", and in accordance with recognized industry practices.
- B. Multiple circuits within a single raceway shall not be permitted under this section.
- C. Splices in cable runs shall not be permitted in this section.

END OF SECTION

SECTION 26 04 71 FEEDER CIRCUITS

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK

- A. Feeder circuit work is indicated by drawings and schedules.
- B. The feeder circuits shall include furnishing and installing a complete wire and conduit system between distribution panelboards and major 3 phase loads, between power panels and 3 phase motor loads.
- C. Types of equipment to be furnished and installed in this section include the following:
 - Rigid Metal Conduit
 - Electrical Metallic Tubing (EMT)
 - Intermediate Metal Conduit (IMC)
 - Wires and Cables
 - Junction Boxes
 - Pull Boxes
 - Conduit Bodies
 - Bushings
 - Locknuts
 - Supporting Devices

PART 2 – PRODUCTS

2.1 FEEDER CIRCUITS

- A. Furnish and install each feeder circuit with assembly of materials, including but not necessarily limited to, conduit, wire, pull boxes, junction boxes and other items and accessories needed for a complete installation. Where materials or components are not otherwise indicated, comply with NEC, NEMA and established industry standards for applications indicated.

PART 3 – EXECUTION

3.1 INSTALLATION OF FEEDER CIRCUITS

- A. Install feeder circuits, complying with equipment manufacturer's written instructions, applicable requirements of NEC, NEMA and NECA's "Standard of Installation", and in accordance with recognized industry practices.
- B. Multiple circuits within a single raceway shall not be permitted under this section.
- C. Splices in cable runs shall not be permitted in this section.

END OF SECTION

SECTION 26 04 72 BRANCH CIRCUITS

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK

- A. Branch circuit work is indicated by drawings.
- B. The branch circuits shall include furnishing and installing a complete wire and conduit or cable system between panelboards and lighting fixtures, receptacles, fractional horsepower motors, and small single-phase loads.
- C. Types of equipment to be furnished and installed in this section include the following:
 - Rigid Raceways – See Section 260110
 - Electrical Metallic Tubing (EMT)
 - MC (Metal Clad) (Concealed Work only)
 - Wires and Cables
 - Junction Boxes
 - Pull Boxes
 - Conduit Bodies
 - Bushings
 - Locknuts
 - Supporting Devices

PART 2 – PRODUCTS

2.1 BRANCH CIRCUITS

- A. Furnish each branch circuit with an assembly of materials, including but not necessarily limited to, conduit, wire, cable, pull boxes, junction boxes and other items and accessories needed for a complete installation. Where materials or components are not otherwise indicated, comply with NEC, NEMA and established industry standards for applications indicated.

2.2 CONVENIENCE BRANCH CIRCUITS

- A. Intent:
 - 1. The intent of this portion of the specifications is to describe the requirements of a convenience circuit as it applies to 120-volt receptacles.
 - 2. All convenience branch circuits may consist of more than one 120-volt receptacle.
- B. Convenience Circuit - General: A circuit consisting of a phase and neutral conductor, which may share its neutral with other phase conductors provided that the neutral conductor does not become overloaded due to circuit phase relationship. This type of circuit shall also include an equipment grounding conductor as described under the grounding section of the specifications.
- C. Convenience Circuit - Dedicated: A circuit consisting of a phase and neutral conductor which DOES NOT share conductors with any other circuits. This type of circuit shall also include an equipment grounding conductor as described under the grounding section of the specifications.

PART 3 – EXECUTION

3.1 INSTALLATION OF BRANCH CIRCUITS

- A. Install branch circuits, complying with equipment manufacturer's written instructions, applicable requirements of NEC, NEMA, and NECA's "Standard of Installation", and in accordance with

recognized industry practices.

- B. Multiple circuits within a single raceway or cable shall be permitted under this section. It shall be the responsibility of the Electrical Contractor to assure that the neutral conductors do not become overloaded due to circuit phase relationship, and isolated grounds not become voided or compromised due to miswiring or wrong connections.
- C. The Electrical Contractor shall use metal clad cable in lieu of electrical metallic tubing (EMT) above tile ceilings as fixture drops only. Metal clad cable shall be supported from building structure of fixture support wires only. Securing cables to the ceiling support system shall not be acceptable. In all areas of exposed construction, electrical metallic tubing (EMT) shall be installed.

END OF SECTION

SECTION 26 04 75
ELEVATOR ELECTRICAL SYSTEMS**PART 1 – GENERAL****1.1 DESCRIPTION OF WORK**

- A. Elevator electrical work is indicated by drawings, schedules and specifications.
- B. The feeder circuits, branch circuits and fire alarm interface shall include, but not be limited to, furnishing and installing a complete wire and conduit system with required equipment and components. This shall occur between the building's distribution panelboard, branch circuit panelboard, the fire alarm control panel and the elevator equipment, machine room, hoistway and elevator lobby.
- C. Types of equipment to be furnished and installed in this section shall include, but not be limited to, the following:
 - 1. Lighting (branch circuits)
 - 2. Power (feeder circuits)
 - 3. Control (fire alarm system)
 - 4. Signal (telephone system) (when required)

PART 2 – PRODUCTS**2.1 LIGHTING**

- A. Furnish and install within the elevator machine room on strike side of machine room door, a 30 amp, 2 pole fused disconnect switch with conduit and wire to a junction box in the hoistway, final location of junction box shall be as directed by the elevator contractor.
- B. The non-fused disconnect switch shall be connected to the local branch circuit panelboard with 2 # 12 + 1 # 12 ground in ¾" conduit. This circuit shall be used to provide service to the elevator car lighting, exhaust fan and any other small loads required by the elevator equipment.

2.2 POWER

- A. Furnish and install within the elevator machine room on strike side of machine room door, a 60-amp, 3 pole fused disconnect switch with auxiliary contacts, with conduit and wire to the elevator controller, refer to the single line diagram for conduit and wire size. Fuse type and size shall be as directed by the elevator manufacturer. The auxiliary contacts shall be used to disconnect the control panel's battery backup during maintenance.
- B. Furnish and install within the distribution panelboard a 3-pole molded case circuit breaker with a shunt trip device, auxiliary contact and conduit and wire to the elevator disconnect switch. Refer to the single line diagram for the circuit breaker size and type and the conduit and wire size. The auxiliary contacts shall be used to disconnect the control panel's battery backup.
- C. Furnish and install a 20 amp, 120 volt, single phase power source for the molded case circuit breaker's shunt trip device from a local branch circuit panelboard.

2.3 CONTROL

- A. Furnish and install smoke detectors within areas of the building associated with the elevator as follows:
 - 1. Elevator Lobbies one on each level
 - 2. Hoistway at the top of the shaft. In addition to the smoke detector, furnish and install a heat detector (when the building is sprinkled).
 - 3. Machine Room in addition to the smoke detector, furnish and install a heat detector (when the building is sprinkled).

- B. Each elevator lobby, hoistway and machine room smoke detector shall be zoned separately from each other and from the floor detectors. These detectors shall be wired and programmed to form a three (3) circuit control scheme for elevator recall as outlined in the National Fire Alarm Code 3-8.14.6.
- C. When the building is sprinkled the elevator machine room and the elevator hoistway shall have a heat detector installed. This detector shall be installed within 2 feet of the sprinkler head in accordance with the National Fire Alarm Code 3-8.15.2. The heat detector shall be furnished based on the Response Time Index (RTI) of both the heat detector and the sprinkler head. This detector shall be wired to the fire alarm control panel to provide for elevator shutdown in accordance with the National Fire Alarm Code 3-8.15.
- D. Furnish and install a shunt trip device and auxiliary contact with power source on the elevator molded circuit breaker located in the distribution panelboard. When the building is sprinkled this device shall be wired to the fire alarm control panel in accordance with ANSI/ASME A17.1 – 1996, Rule 102.2 (C) and National Electrical Code 620-51.

2.4 COMMUNICATIONS

- A. Furnish and install a four (4) pair, Cat 6 cable in ¾" conduit between the telephone terminal backboard and a junction box located in the elevator hoistway. Final location of the junction box shall be as directed by the elevator contractor.

PART 3 – EXECUTION

3.1 INSTALLATION OF ELEVATOR ELECTRICAL SYSTEMS

- A. Install equipment and components, complying with equipment manufacturer's written instructions, applicable requirements of the National Electrical Code (NEC), NEMA and NECA's "Standard of Installation", and in accordance with recognized industry practices.

3.2 CONTROL WIRING

- A. The Electrical Contractor shall furnish and install all required wiring between the fire alarm control panel and the elevator controller to provide for elevator recall when the building has an alarm condition. This contractor shall consult and cooperate with the elevator installing contractor.
- B. The Electrical Contractor shall furnish and install all required wiring between the fire alarm control panel and the smoke detectors in the elevator lobbies, and the smoke and heat detectors in the elevator machine room and hoistway. This contractor shall consult and cooperate with the fire alarm manufacturer in providing the required programming and wiring needed to complete the recall system as required by the Elevator Code, NEC, NFPA and the NATIONAL FIRE ALARM CODE.
- C. The Electrical Contractor shall furnish and install all required wiring between the fire alarm control panel and the shunt trip circuit breaker located in the distribution panel. This wiring and programming shall provide for the trip signal from the fire alarm control panel and a supervisory signal to the fire alarm control panel as "TROUBLE" for the loss of the trip power source. This wiring and programming shall be in accordance with the requirements of the NEC and the NATIONAL FIRE ALARM CODE.

3.3 POWER WIRING

- A. The Electrical Contractor shall furnish and install an elevator circuit breaker in the distribution panel of the size and type as indicated on the single line diagram. This circuit breaker shall be complete with a shunt trip device rated 120-volt A.C and auxiliary contact. The shunt trip device shall be wired to an external 120-volt power source in a local branch circuit panel with a 20 amp – 1 pole circuit breaker and 2 # 12 + 1 # 12 ground in ¾" conduit. Trip control and supervisory shall be furnished and installed as indicated above under 3.1 paragraph "C".

- B. The Electrical Contractor shall furnish and install within the elevator machine room a fused elevator disconnect switch of the size and type indicated on the single line diagram. This disconnect switch shall be furnished with an auxiliary contact and wired to the elevator controller's "optional" battery system for disconnect and shutdown. If the "optional" battery system is not selected then the auxiliary contact remains un-wired. All required wiring shall be in accordance with the requirements of the NEC and the ELEVATOR CODE. The Electrical Contractor shall consult and cooperate with the elevator installer in providing this function.
 - C. The Electrical Contractor shall furnish and install a 30 amp, 2-pole fused disconnect switch within the elevator machine room. This switch shall provide power to the elevator car lighting and exhaust system, the switch shall be connected to the elevator equipment in accordance with the elevator contractor's requirements. The switch shall be connected to a local branch circuit panel with a 20 amp – 1 pole circuit breaker and 2 # 12 + 1 # 12 ground in ¾" conduit.
- 3.4 COMMUNICATION WIRING
- A. The Electrical Contractor shall furnish and install one (1) four pair, CAT-6 cable in ¾" conduit between the elevator equipment and the building's telephone system. The Electrical Contractor shall consult and cooperate with the Elevator Contractor in making this connection.

END OF SECTION

SECTION 26 05 10 BUILDING LIGHTING

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK

- A. Lighting fixture work is indicated by specifications, drawings and schedules.
- B. Types of lighting fixtures in this section include the following:
 - 1. LED
- C. Applications of lighting fixtures required for the project include the following:
 - 1. General Lighting.
 - 2. Supplementary Lighting.
 - 3. Emergency Lighting.

1.2 SUBMITTALS

- A. Product Data: Submit manufacturer's data on building lighting fixtures.
- B. Shop Drawings: Submit dimensioned drawings of lighting fixture installations, including but not necessarily limited to, layout, relation to associated panelboards, and connections to panelboards. Submit fixture shop drawings in booklet form with separate sheet for each fixture, assembled in luminaire "type" alphabetical order, with proposed fixture and accessories clearly indicated on each sheet.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Each lighting fixture type specified represents a specific style and quality of fixture acceptable for this project.
- B. The Engineer reserves the right to reject any shop drawing and to request a resubmission should the contractor submit a shop drawing of an equivalent manufacturer which is viewed as being of an incompatible style or inferior quality.
- C. No fixture shop drawing shall be submitted, nor will any be accepted, for any manufacturer which is not specifically listed for that fixture type. When a fixture manufacturer is listed for a specific fixture type, this does not provide him with the right to submit for fixtures he is not listed under. A bidding Contractor may elect to bid using non-listed fixtures for the listed Lighting Representatives. The Engineer and the Architect shall make the final decision on whether the submitted fixture meets the project's requirements during shop drawing review.
- D. Should the Contractor be unable to obtain approval of the resubmitted manufacturer, then he should submit the basis of design specified manufacturer/fixture.

2.2 LIGHTING FIXTURES

- A. Provide lighting fixtures of the size, type and rating indicated complete with, but not necessarily limited to, housings, lamp holders, reflectors, ballast, lamps, mounting frames, pendants and wiring; wired and connected in place, complete, tested and left in satisfactory operating condition.
- B. LED Drivers
 - 1. All LED fixtures shall be provided with integral drivers (unless noted otherwise) and must operate at line voltage as indicated on drawings (unless noted otherwise).
 - 2. LED drivers shall have operating temperature of 50°F - 140°F unless noted otherwise.
 - 3. LED drivers shall carry a 5-year warranty.

- C. Fixture Lamps: For the type, number and color of the fixture lamps, refer to the Lighting Fixture Schedule on the drawings.

PART 3 – EXECUTION

3.1 INSTALLATION OF LIGHTING FIXTURES

- A. Install lighting fixtures at locations and heights as indicated, in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation", NEMA Standards and with recognized industry practices to ensure that lighting fixtures fulfill requirements of the project.
- B. Install lighting fixtures in removable tile ceilings using 3/8" flexible metal conduit with 3 # 12 awg. conductor. Maximum length of flexible lead shall not exceed 60". Flexible lead shall extend from the fixture to the junction box. The junction box shall be securely fastened to the building structure above the removable tile ceiling and shall not serve more than two (2) lighting fixtures, nor shall the junction box support any of the lighting fixtures.

3.2 LIGHTING FIXTURE MOUNTING

- A. 1' x 4', 2' x 2' and 2' x 4' fixtures installed in a removable tile ceiling shall be installed using T-Bar grid safety clips as provided by the fixture manufacturer and as required by the NEC.
- B. 2' x 2' and 2' x 4' fixtures installed in a removable tile ceiling shall be installed using support wires at all four corners of the fixture. The support wires shall be carried up to the building structure and securely anchored using screwed or bolted hardware. Pressure type clips will not be acceptable. The Electrical Contractor shall be responsible for installing or having installed these four (4) support wires.
- C. 1' x 4' fixtures installed in a removable tile ceiling shall be installed using support wires at two (2) corners of the fixture. The support wires shall be carried up to the building structure and securely anchored using screwed or bolted hardware. Pressure type clips will not be acceptable. The Electrical Contractor shall be responsible for installing or having installed these Two (2) support wires.
- D. Downlights installed in a removable tile ceiling shall be installed using 24" spreader bars attached to the T-Bar grid system. Two (2) support wires shall be installed, one (1) on each side of the fixture and centered between the spreader bars, these support wires shall be carried up to building structure and securely anchored using screwed or bolted hardware. Pressure type clips will not be acceptable. The Electrical Contractor shall be responsible for installing or having installed these two (2) support wires.
- E. Pendant lighting fixtures, either chain, cable or stem hung below a removable tile ceiling shall be installed in accordance with fixture manufacturer's written instructions and recommendations. The Electrical Contractor shall furnish and install support wire or threaded rod from the fixture mounting hardware up to building structure and securely anchor using screwed or bolted hardware. Pressure type clips will not be acceptable. These support devices shall be independent from the ceiling T-Bar grid system, the system may be used as a guide, but in no way shall the T-Bar grid system carry any of the weight produced by the fixture or it's support devices.
- F. Surface mounted fixtures installed on removable tile ceilings or dry wall ceilings shall be installed in accordance with fixture manufacturer's written instructions and recommendations.
 - 1. Fixtures installed on removable tile ceilings shall be anchored to the T-Bar grid system using snap-on clips with threaded studs and wing nuts. The Electrical Contractor shall furnish and install a support wire from each snap-on clip carried up to building construction and securely anchor using screwed or bolted hardware.
 - 2. Fixtures installed on dry wall ceilings shall be mounted using spring-loaded toggle bolts. The number and location of the anchors shall depend on the fixture manufacture's written

instructions and recommendations. It shall be the responsibility of the Electrical Contractor to follow these instructions and recommendations.

3.3 ADJUST and CLEAN

- A. Clean lens, reflectors and interiors of all lighting fixtures of dirt and construction debris upon completion of installation.
- B. Protect installed lighting fixtures from damage during the remainder of the construction period.

3.4 FIELD QUALITY CONTROL

- A. Upon completion of the installation of the lighting fixtures, and after the building circuitry has been energized, apply electrical energy to demonstrate capability and compliance with project requirements. Where possible, correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.
- B. At the time of Substantial Completion, replace lamps in lighting fixtures which are observed to be noticeably dimmed after Contractor's use and testing, as judged by the Architect/Engineer. Furnish stock or replacement lamps amounting to 15% (but not less than one (1) lamp in each case) of each type and size used in each type of fixture. Deliver the replacement stock as directed to the Owner's storage area.
 - 1. Refer to Division 1 sections for the replacement/restoration of lamps in lighting fixtures, where used for temporary lighting prior to the time of Substantial Completion.
- C. Replace defective and burned out lamps for a period of one (1) year following the time of Substantial Completion.

3.5 GROUNDING

- A. Provide tight equipment grounding connections for each lighting fixture installation, in accordance with fixture manufacturer's recommendations and the NEC's requirements.

END OF SECTION 26 0510

SECTION 26 05 20 ROADWAY & PARKING AREA LIGHTING

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of roadway and parking area lighting work is indicated by drawings and schedules.
- B. Applications of roadway and parking area lighting in this section include the following:
Private roadways.
Automobile parking lots.
Pedestrian walkways.
Building entrances.
- C. Excavation and backfilling for roadway and parking area lighting poles, standards and foundations are specified in applicable Division 26 General Provisions sections.
- D. Concrete for embedding poles, and for pole foundations and footings are specified in applicable Division 26 General Provision sections.

1.2 SUBMITTALS

- A. Product Data: Submit manufacturer's data on roadway and parking area lighting units, including certified dimension drawings of components including, but not necessarily limited to, fabricated poles and standards, and hardware.

PART 2 – PRODUCTS

2.1 GENERAL

- A. Provide concrete bases, standards and luminaries of sizes, types and ratings indicated; complete with but not necessarily limited to anchor bolts, housings, lamps, lampholders, reflectors, ballasts, starters, lighting brackets and wiring; wired and connected in place, tested and left in satisfactory operating condition. See schedule on the drawings for types of standards and luminaries. Type letters are keyed with fixture letters indicated at the outlets on the drawings.
- B. Material: Extruded aluminum.
- C. Configuration: Anchor base type with handhole and cover where indicated.
- D. Metal Lighting Standard Accessories: Provide accessories for metal lighting standards, including anchor bolts, as recommended by standard manufacturer of sizes and materials needed to fulfill loading and erection application requirements.
- E. Manufacturers: Subject to compliance with requirements, provide products of one of the following (for each type of roadway and parking area lighting unit): As specified under "PRODUCTS".

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Install roadway and parking area lighting units as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC, NESC and NEMA standards, and with recognized industry practices to ensure that lighting units fulfill requirements.
- B. Use belt slings or rope (not chain or cable) to raise and set finished poles and standards to protect finishes.
- C. Set poles and standards plumb. Support adequately during backfilling, or anchoring to foundations.

3.2 ADJUST AND CLEAN

- A. Clean standards and luminaries of dirt and debris upon completion of installation.

- B. Protect standards and luminaries from damage during remainder of construction period.

3.3 FIELD QUALITY CONTROL

- A. Upon completion of installation of roadway and parking area lighting fixtures, and after building circuitry has been energized, apply electrical energy to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.
- B. At the time of Substantial Completion, replace lamps in lighting fixtures which are observed to be noticeably dimmed after Contractor's testing, as judged by Architect/Engineer.

3.4 GROUNDING

- A. Provide tight equipment grounding connections for each lighting fixture installation.

END OF SECTION

SECTION 26 06 01 LIGHTNING PROTECTION SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK

- A. Lightning protection system work is indicated by specifications.
- B. Types of lightning protection system equipment and components specified in this section include the following:
 - Air terminals.
 - Conductors.
 - Connectors.
 - Cable Splicers.
 - Ground rods.
 - Rod clamps.
 - Bonding plates.

1.2 QUALITY ASSURANCE

- A. ANSI/NFPA Compliance: Comply with NEC and NFPA No. 780, "Lightning Protection Code", as applicable to materials and installation of lightning protection components, and wiring.
- B. UL Compliance: Comply with UL 96, "Lightning Protection Components" pertaining to design, materials and sizing of lightning protection components and devices. Provide components and devices which are UL listed and labeled.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's data on lightning protection equipment, components and devices.
- B. Shop Drawings: Submit dimensioned layout drawings of all lightning protection system equipment, components and devices including conductor sizing, routing and connections.
- C. UL Certificate: Provide Owner with UL Master Label for overall system which shall be suitable for fastening to building for display. Comply with UL 96A, "Installation Requirements for Lightning Protection Systems."

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide lightning protection and components of one of the following manufacturers and their representative:
 - East Coast Lightning Equipment
 - Erico Lightning Protection
 - Heary Bros., Inc.
 - National Lightning Protection Corp.
 - Denver, Colorado 80216
 - Thompson Lightning Protection, Inc.
 - VFC Lightning Protection

2.2 LIGHTNING PROTECTION SYSTEM COMPONENTS

- A. Provide lightning protection system equipment and components, of types, sizes, and ratings for

service indicated, which comply with manufacturer's standard materials, design and construction in accordance with published product information, and as required for a complete installation. Where type or material is not otherwise indicated, comply with NFPA 780 and UL 96 Standards.

2.3 ANCILLARY COMPONENTS

- A. Air Terminal: Copper with low solid bronze base; 3/8 inch diameter extending 10 inches above the object they protect.
- B. Conductors: Copper cable; 28 strand, 16 gauge; 220 lb. per 1000 feet; structural steel columns may be substituted for the down conductors.
- C. Connectors: Solid bronze cable connector with stainless steel pressure screws.
- D. Ground Rod: Copper clad, 5/8 inch diameter x 10 feet.
- E. Rod Clamp: Bronze ground rod clamp with stainless bolts.
- F. Bonding Plate: Cast bronze flat metal bonding plate with mild steel welding plate 1/4"x4"x4" for attachment to steel columns or beams. Steel plate to be electrically welded to the steel column or beam. Plate shall be furnished with four stainless steel bolts and nuts to attached bonding plate welding plate.

PART 3 – EXECUTION

3.1 INSTALLATION OF LIGHTNING PROTECTION SYSTEMS

- A. Install lightning protection systems, in accordance with equipment manufacturer's written instructions, in compliance with applicable requirements of NFPA 780 and with UL 96A lightning protection standards, to ensure that lightning protection system complies with requirements.
- B. Interconnect metals as required by the Underwriters' Laboratories code such as cold water pipe, sewer, etc., with lead coated copper strap type pipe bonding clamps.
- C. Concealed down conductors within building construction where applicable.
- D. Coordinate with roofing work, as necessary to interface the installation of the lightning protection system.
- E. Install conductors with direct paths from air terminals to ground connections. Do not use metal casings of structure/equipment as a ground path. Avoid sharp bends and narrow loops.

3.2 TESTING

- A. Upon completion of installation of lightning protection system, test resistance-to-ground level. Where tests show resistance-to-ground is over 25 ohms, the Contractor shall take appropriate action to reduce resistance to 25 ohms or less by driving additional ground rods and/or treating soil in the proximity to the ground rod with sodium chloride, calcium chloride, copper sulphate, or magnesium. Then retest to demonstrate compliance with requirements.

END OF SECTION

SECTION 26 06 06 AUTOMATIC TRANSFER SWITCHES

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of A.T.S. work is indicated by drawings, schedules and specifications.
- B. Types of A.T.S. specified in this section include the following:
Automatic Transfer Switches

1.2 SUBMITTALS

- A. Product Data: Submit manufacturer's data on A.T.S. and components.
- B. Shop Drawings: Submit dimensioned drawings of automatic transfer switches and automatic transfer switches with bypass-isolation switches, including accessories, but not limited to the following:
 - 1. System schematic diagram showing all required conduit, wiring interconnections, sizes and quantities.
 - 2. Complete conduit, electric power, control schematics and flow diagrams.
 - 3. Ladder type schematic electrical diagrams with legend identifying all devices on diagrams.

PART 2 – PRODUCTS

2.1 EMERGENCY POWER SYSTEM

- A. Furnish A.T.S. and components of types, ratings, and electrical characteristics indicated, consisting of, but not limited to, power transfer module, control module and equipment housing with all required interconnections.

2.2 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with requirements, provide products of one of the following:
Automatic Switch Company (ASCO)
Florham Park, New Jersey 07932
Russelectric, Inc.
South Short Industrial Park
Hingham, MA. 02043
- B. These specifications are designed and written around the characteristics of ASCO Automatic Transfer Switches and represent the minimum requirements for all other listed manufacturers.

2.3 AUTOMATIC TRANSFER SWITCHES

- A. The automatic transfer switches shall consist of a power transfer module and a control module, interconnected to provide a complete automatic power transfer operation. The switch shall be mechanically held and electrically operated by a single solenoid mechanism energized from the source to which the load is to be transferred. The switch shall be rated for continuous duty and be inherently double throw. The switch shall be mechanically interlocked to ensure only one of two positions--normal or emergency.
- B. The automatic transfer switches shall be suitable for use with an engine-driven generator source.
- C. All main contacts shall be of silver composition. The operating transfer time in either direction shall not exceed one-sixth (1/6) of a second.
- D. All contacts, coils, springs and control elements shall be conveniently removable from the front of the transfer switch without major disassembly or disconnection of power conductors.

- E. The control module shall be supplied with a protective cover and be mounted separately from the transfer switch for ease of maintenance. Sensing and control logic shall be solid-state and mounted on plug-in printed circuit boards. Printed circuit boards shall be keyed to prevent incorrect installation. Interfacing relays shall be industrial control grade plug-in type with dust covers.

2.4 COMPLIANCE WITH CODES AND STANDARDS

- A. The automatic transfer switch and the bypass-isolation switch shall conform to the current requirements of:
 - 1. Underwriters Laboratories UL-1008
 - 2. National Electrical Code Articles 517, 700, 701 and 702.
 - 3. National Fire Protection Association 99 and 110.
 - 4. National Electrical Manufacturer's Association Standard ICS-2-447.
- B. Automatic transfer switches utilizing components of molded case circuit breakers, contactors or parts thereof which have not been intended for continuous duty or repetitive load transfer switching shall not be acceptable.
- C. Transfer switches rated 400 amperes and less shall be suitable for 100 percent tungsten-filament lamp load.
- D. The automatic transfer switch shall be rated to withstand the RMS symmetrical short circuit current available at the automatic transfer switch terminals with the type of overcurrent protection and voltage as indicated on the single line riser diagram.

2.5 ACCESSORIES

- A. Provide accessory devices as follows:
 - 1. Two (2) N.O. and two (2) N.C. auxiliary contacts.
 - 2. Solid Neutral (ASCO Accessory No. 22).
 - 3. Overlapping neutral transfer contacts (ASCO Accessory No. 28)
 - 4. In-Phase Monitor (ASCO Accessory No. 27)
 - 5. Engine Exerciser (ASCO Accessory No. 11C) Install on one (1) switch only.

2.6 SWITCH TYPE

- A. The automatic transfer switches and controls shall be mounted in a NEMA Type 1, General Purpose enclosure. Switch types shall be as follows:
 - 1. Automatic Transfer Switch: ASCO Type 300

PART 3 – EXECUTION

3.1 INSTALLATION OF EMERGENCY POWER SYSTEM

- A. Install Emergency Power System as indicated in contract documents, and in accordance with equipment manufacturer's written instructions, and with recognized industry practices, to ensure that the system equipment complies with requirements. Comply with requirements of NEC and applicable portions of NECA's "Standard of Installation" pertaining to general electric installation practices.
- B. The Electrical Contractor shall furnish and install all power wiring as indicated and all control wiring as required by the automatic transfer switch and engine generator manufacturers.

3.2 GROUNDING

- A. Provide equipment grounding connections, sufficiently tight to assure permanent and effective

ground, for Optional Emergency Power System equipment as indicated in contract documents.

3.3 FIELD QUALITY CONTROL

- A. Upon completion of installation of Emergency Power System equipment, and after building circuitry has been energized with normal power source, test system to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new units and proceed with retesting.

3.4 OPERATION, MAINTENANCE, INSTRUCTION MANUALS

- A. Provide three (3) operation and maintenance instruction manuals, including spare parts list, to the Owner.

END OF SECTION 26 0606

SECTION 26 06 12
EMERGENCY GENERATOR SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK

- A. Provide a 500-kW integrated paralleling, standby power system to supply electrical power at 480 Volts, 60 Hertz, 3-Phase. The system will utilize generators rated 250 kW. The generators shall consist of a liquid cooled spark-ignited engine, a synchronous AC alternator, a paralleling switch, and system controls with all necessary accessories for complete operating system, including but not limited to the items as specified hereinafter.
- B. Types of Emergency Generator System equipment required for project include the following:
 - Natural gas engine-driven generators.
 - Weatherproof Enclosures
 - Fuel piping
 - Battery Chargers
 - Generator Support Panels

1.2 SUBMITTALS

- A. Product Data: Submit manufacturer's data on engine driven electric generator systems and components.
- B. Shop Drawings: Submit dimensioned drawings of engine driven generator units and accessories, including but not limited to the following:
 - 1. System schematic diagram showing all piping and wiring interconnections, sizes and quantities.
 - 2. Installation fact sheet giving fuel, coolant, lubricating oil, exhaust, ventilation, and other pertinent requirements.
 - 3. Complete piping, conduit, electric power and control schematics, and flow diagrams.
 - 4. Engine generator and enclosure elevations (1/10th scale or larger) showing the locations, size, and dimensions of all required Owner interfaces to the package.
 - 5. Ladder type schematic electrical diagrams with legend identifying all devices on diagrams.
 - 6. Factory certified horsepower and fuel consumption data.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, furnish Emergency generator systems of one of the following:
 - Caterpillar, Inc.
 - MTU Onsite Energy
 - Generac Industrial Power
 - Kohler Co.
 - Cummins Power Generation

2.2 ENGINE GENERATOR UNIT

- A. The following specifications are designed and written around the characteristics of a Generac Engine Generator and represent the minimum requirements for all other listed manufacturers.
- B. Natural Gas Engine Generators: Furnish an alternating current generators as indicated in contract

documents, with a standby rating of 250KW/313KVA @ 277/480 volt, 3 phase, 4 wire, 60 Hertz, 0.8 percent power factor each. Furnish all the following components, accessories and construction features as required for a complete and satisfactory operating system. 3 phase, 4 wire, 60 Hz, 0.8 percent power factor, 453 KW, natural gas engine. All accessories and the following components and construction features as required for a complete and satisfactory operating system.

2.3 ENGINE

- A. The engine shall be six (6) cylinder, 2 or 4 cycle, water cooled, turbo-charged, after-cooled, with not less than 785 cubic inch displacement. Engine speed shall be governed by a gear driven governor to maintain generator frequency within 0.5% Hertz from no load to 100% rated load.
- B. A 24-volt D.C., negative ground electric starting system consisting of a minimum of 625 AMPs cranking current at an ambient temperature of 0 deg. F, A 65 AMP battery alternator, battery racks and a complete set of battery cables.
- C. Batteries shall be selected and furnished to comply with NFPA 110, Level 1 starting requirements. Each battery (two required) shall be 12-volt, maintenance free, lead-calcium hybrid type with sealed cells. The batteries shall be commissioned according to battery manufacturer's instructions.

2.4 ALTERNATOR

- A. The alternator shall be four (4) pole, rotating field, self-ventilated, drip-proof construction. Class "H" insulation system per NEMA MG1-1.66, with standard 130 deg. C temperature rise at standby power rating.
- B. Furnish skewed rotor and 2/3 pitch windings to smooth voltage wave form, minimize field heating and voltage harmonics.
- C. Rotor shall be a dynamically balanced assembly, with a single bearing and direct coupled to engine by a flexible drive disc. Furnish full amortisseur (damper) windings to help minimize voltage deviations and heating effects under unbalanced load conditions.
- D. The voltage regulator shall be solid state and furnish torque-matched underfrequency compensation to optimize motor starting performance and to assist the engine during transient load conditions. Voltage regulation from no load to full load shall be +/- 2%.
- E. The exciter shall be a permanent magnet, field rotating, brushless armature and shall power the main alternator field windings through shaft mounted, three (3) phase, full wave silicon diode rectifiers. Semi-conductor surge suppressors shall protect the diodes from transient overvoltages induced by load surges.
- F. The shunt excitation system shall derive its power from the main output of the alternator.

2.5 CONTROL PANEL

- A. Furnish a unit-mounted, automatic start, level 1 control panel, with suitable vibration isolators. Panel shall consist of, but not be limited to, the following:

Equipment

- 1. Errorproof wiring harness for electrical connections.
- 2. Lamp test switch.
- 3. Cyclic cranking
- 4. Overcrank and starter unmesh protection.
- 5. Two-wire remote start/stop terminals.
- 6. AC interlock to prevent starter re-engagement with engine running.
- 7. Overspeed detection.
- 8. Voltage-adjust Rheostat +/- 5%.

9. Run - OFF/RESET - Auto switch.
10. Emergency stop pushbutton.
11. Low coolant level detection.
12. D.C. circuit protection.
13. Panel lamps (2).
14. Cool-down timer (5 minutes)
15. Alarm horn and silencing switch.

Instruments

1. A.C. Voltmeter, 3-1/2", 2% full scale accuracy
2. A.C. Ammeter, 3-1/2", 2% full scale accuracy.
3. A.C. Frequency meter, 3-1/2", 0.5% full scale accuracy.
4. D.C. Voltmeter.
5. Engine water temperature.
6. Engine oil temperature.
7. Running time meter.
8. Phase selector switch, seven (7) position.

Indicator Lamps

1. Overcrank
2. Low oil pressure
3. High engine temperature
4. Overspeed
5. Emergency stop
6. Not-In-Auto
7. System ready
8. Low battery volts
9. Battery charge fault
10. Low fuel.
11. Prealarm high engine temperature
12. Prealarm low oil pressure.
13. Low water temperature.
14. Auxiliary alarm
15. Auxiliary prealarm
16. Air damper.

- B. Furnish and install all required control wiring, fuses, fuse blocks, terminal blocks, nameplates, fault contacts, auxiliary contacts, and metering current transformers.

2.6 COOLING SYSTEM

- A. Engine shall have a unit-mounted radiator with engine-driven cooling fan. The radiator shall be sized to adequately cool the engine under full load conditions as outlined, in a 125 degrees F ambient temperature and have adequate capacity for additional heat radiated by engine. A fan and radiator guard shall be included.

- B. Anti-freeze shall be a 50% mixture of ethylene glycol and water and shall contain a suitable rust inhibiting agent and be installed in the cooling system. The unit shall be furnished with, as a minimum total replacement, an additional supply of 50% ethylene glycol and water coolant mixture.

2.7 EXHAUST SYSTEM

- A. Furnish one (1) critical grade silencer, with a side inlet and end outlet configuration. Inlet and outlet shall be NPT thread.
- B. Silencer shall include a condensate drain plug, and be mounted on the enclosure roof and piped to the engine by means of a stainless-steel exhaust flexible piping.
- C. Silencer outlet end shall have a 90-deg. exhaust pipe extension terminating vertically, with a counterbalanced rain cap.

2.8 ENGINE HEATERS AND ACCESSORIES

- A. Coolant heater shall be a 2500 watt, 240-volt, single phase thermostatically controlled device. The heater shall be furnished, installed and wired at the factory. Furnish and install a low water temperature alarm contact to close when water temperature falls below 50 deg. F. Interconnect the alarm contact device to the proper alarm terminals in the generator control panel and remote alarm annunciator.
- B. Lube oil heater shall be a 150-watt, 120-volts, single phase thermostatically controlled device. The heater shall be furnished, installed and wired at the factory.
- C. Battery heaters shall be a thermostatically controlled, low wattage pad type device, suitable for operation on a 120 volt, single phase circuit.

2.9 BATTERY CHARGER

- A. Charger shall be a fully automatic, SCR, float/equalize battery charger. The 24 volt, 10 AMP, silicon controlled rectifier shall be a constant voltage, current limiting charger designed to be permanently connected for float/equalize charging of lead acid starting batteries. The charger shall furnish automatic "Flood-to-Equalize" operation with individual potentiometer adjustments, and shall charge a minimum of 12 lead-acid maintenance free battery cells.
- B. Charger shall be furnished with an oversized transformer and heatsink to allow for constant current charging at 10 AMPs, up to the equalize voltage settings.
- C. The charger shall be furnished in a NEMA 1, general purpose enclosure, with the following equipment, components and features:
 - 1. DC voltmeter
 - 2. DC ammeter
 - 3. ON/OFF power switch
 - 4. Input and output fuse protection and terminal blocks.
 - 5. Operational monitors shall provide visual output as well as individual Form C relay contacts for the following:
 - a. Battery Charger Fault: N.O. contacts close on loss of A.C. input or loss of D.C. output.
 - b. Low Battery Voltage: N.O. contacts close on low battery voltage.
 - c. High Battery Voltage: N.O. contacts close on high battery voltage, contacts not used.
- D. The charger shall be a wall-mounted unit suitable for operation on a 120 volt, single phase power source.

2.10 WEATHER RESISTANT OUTDOOR ENCLOSURE

- A. The diesel engine generator and its required accessories shall be furnished with a factory installed, base mounted, maintenance free, pre-painted forest green outdoor enclosure.
- B. Enclosure shall be made of heavy gauge aluminum, sound attenuated to reduce generator set noise to 85 DBA @ 23', and shall totally enclose the generator set, its accessories and sub-base fuel oil storage tank.
- C. Design Criteria:
 - 1. Rigidity wind test equal to 115 MPH.
 - 2. Roof load equal to 50 lbs. per sq. ft.
 - 3. Rain test equal to 4" per hour.
 - 4. Dimensions: Normal 18' long x 7' wide x 9' high.
- D. Enclosure shall consist of a roof, underframe, two (2) side walls, and two (2) end walls, of prepainted aluminum construction and floor.
 - 1. Roof: One piece cambered roof sheet of .040" thick aluminum with 1/8" extruded aluminum recessed side and end rails.
 - 2. Roof bows: Extruded aluminum "I" beams spaced with roof reinforced to carry silencer load.
 - 3. Side and End Walls: Panels shall be .040" thick aluminum sheet, mill-prepainted, riveted 3" on center.
 - 4. Floor and Underframe: Enclosure will have two (2) "I" beam longitudinal skids with fabricated steel cross members on 12" centers. The diesel generator set is mounted through vibration isolators to steel tapping plates. A full steel floor shall be provided.
 - 5. Door Frames: Welded aluminum frame consisting of extruded alloy 1/8"x4-1/2"x1-1/2", riveted to side panels.
- E. Enclosure Accessories:
 - 1. Four (4) steel lift rings welded to the underframe.
 - 2. Louvers: Motorized intake and gravity discharge louvers shall be all aluminum construction riveted into aluminized steel frame forming a rigid, water-resistant assembly. Louvers shall be properly sized to allow sufficient engine combustion and radiator cooling air flow with a 0.5" H₂O maximum restriction. Birdscreen shall be provided on inlet and exhaust openings.
 - 3. Air Plenums: Furnish vertical intake and discharge 90 deg air plenums for intake and cooling air.
 - 4. Insulation: Furnish 3" acoustic insulation on walls and ceiling, line with perforated metal lining.
 - 5. Access Doors: Furnish four (4) access doors, two (2) on each side of the enclosure, each 38" wide x 80" high with padlockable handles, for servicing and operation of generator set and accessories.
 - 6. Exhaust Hardware: The enclosure shall be furnished with silencer supports, brackets, rain collars and rain shields.
- F. The Weatherproof enclosure shall be complete with, but not limited to the following equipment and components:
 - 1. Two (2) duplex ground fault interrupting weatherproof receptacles, one (1) mounted on each side of the unit, on the inside of the enclosure.
 - 2. Two (2) 100 watt surface-mounted, weatherproof industrial globe with cast guard fixtures. Fixtures to be switched from the instrument door.
 - 3. Generator support panel "GP", located in Gen 1 only, shall be a weatherproof, 24-pole, 100 AMP, 120/240 volt, single phase, 3 wire + ground loadcenter. Loadcenter shall consist of the

following circuits:

- a. Circuit No. 1: (2) 20A/1P C.B. - Battery Charger
 - b. Circuit No. 2: (2) 20A/1P C.B. - Enclosure Lighting
 - c. Circuit No. 3: (2) 20A/1P C.B. - Enclosure Receptacles
 - d. Circuit No. 4: (2) 20A/1P C.B. - Battery Heater Pads
 - e. Circuit No. 5: (2) 20A/1P C.B. - Louver Operator
 - f. Circuit No. 6: (2) 20A/2P C.B. - Engine Coolant Heater
- G. Furnish and install all boxes, conduit and wire required for a complete and operating enclosure.
- 2.11 VIBRATION ISOLATORS
- A. Provide rubber-in-shear vibration isolators for mounting between engine-generator skid and the enclosure. The isolators shall be 95% efficient and sized in accordance with equipment manufacturer's requirements.
- 2.12 CERTIFICATION
- A. This Contractor shall consult and cooperate with the factory authorized dealer in making arrangements for a load bank of proper size to certify this unit's power rating, stability, voltage and frequency regulation for 25%, 50%, 75% and 100% load over a four (4) hour period, with a one (1) hour period for each load increment.
- B. This Contractor shall provide certification, testing and maintenance in accordance with NEC Article 700-4. These records and reports shall be placed in a looseleaf binder and turned over to the Owner for his continued use.

PART 3 – EXECUTION

3.1 INSTALLATION OF ENGINE GENERATOR SYSTEM

- A. Install emergency engine generator sets as indicated in contract documents, and in accordance with the equipment manufacturer's written instructions, Division 26 Section 260000 under the listing "SPECIAL ENGINEERING SERVICES", and with recognized industry practices, to ensure that engine generator sets fulfill requirements. Comply with NFPA standards pertaining to installation of emergency engine generator systems and accessories.
- B. Coordinate with other work, including fuel supply, piping and accessories as necessary to interface installation of emergency generator system work with other work.
- C. Connect fuel piping to emergency generator equipment and comply with manufacturer's instructions where not otherwise indicated.
- D. Perform emergency generator lubrication, equipment startup as specified in Division 26, Section 260000 under the listing "LUBRICATION" and "EQUIPMENT START-UP".
- E. Instruct owner's personnel in the operation and maintenance of Emergency Generator System as specified in Division 26 Section 260000 under the listing "Operation and Maintenance Instructions".

3.2 GROUNDING

- A. Provide equipment grounding connections, sufficiently tight to assure a permanent and effective ground, for system components as indicated in contract documents.

3.3 TESTING

- A. Upon completion of installation of engine generator system and after building circuitry has been energized with normal power source, test engine generator to demonstrate emergency capability and

compliance with requirements. Where possible, field correct malfunctioning units, then retest to demonstrate compliance.

END OF SECTION 26 0612

SECTION 26 06 60**SURGE PROTECTIVE DEVICES (INTEGRAL AND EXTERNAL)****PART 1 – GENERAL****1.1 WORK INCLUDED**

- A. This section describes the material and installation requirements for permanently connected Surge Protective Devices (SPDs) for the protection of all AC electrical circuits.

1.2 STANDARDS

- A. The SPD must comply with most recent edition of:
 - 1. IEEE C62.41.1, IEEE Guide on the Surge Environment in Low-Voltage (1000 V and Less) AC Power Circuits.
 - 2. IEEE C62.41.2, IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits
 - 3. IEEE C62.45, IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits.
 - 4. National Electrical Code: Article 285
 - 5. UL 1283 - Electromagnetic Interference Filters
 - 6. UL 1449, Third Edition, effective September 29, 2009 – Surge Protective Devices

1.3 SUBMITTALS

- A. Submit shop drawings and product information for approval and final documentation in the quantities listed according to the Conditions of the Contract. All transmittals shall be identified by customer name, customer location, and customer order number.
- B. Submittals shall include UL 1449 3rd Edition Listing documentation verifiable by visiting www.UL.com, clicking “Certifications” link, searching using UL Category Code: VZCA.
 - 1. Short Circuit Current Rating (SCCR)
 - 2. Voltage Protection Ratings (VPRs) for all modes
 - 3. Maximum Continuous Operating Voltage rating (MCOV)
 - 4. I-nominal rating (I-n)
 - 5. SPD shall be Type 1 UL listed and labeled
- C. Upon request, an unencapsulated but complete SPD shall be presented for visual inspection.
- D. Minimum of ten (10) year warranty

1.4 MANUFACTURERS

- A. External
 - Advanced Protection Technologies (APT)
 - Current Technology (TG3 Series)
 - Siemens
 - Thor (TSR Series)

1.5 LISTING REQUIREMENTS

- A. SPD shall bear the UL Mark and shall be listed to most recent editions of UL 1449 and UL 1283. “Manufactured in accordance with” is not equivalent to UL listing and does not meet the intent of this specification.

- B. SPD and performance parameters shall be posted at www.UL.com under Category Code: VZCA. Products or parameters without posting at UL.com shall not be approved. (To access UL Category Code click on Certifications in the left menu bar of UL's home page. Type "VZCA" into the Category Code search box and click Search.)

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Engage a firm with at least ten (10) years of experience in manufacturing transient voltage surge suppressors.
- B. Manufacturer shall be ISO 9001 or 9002 certified.
- C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (10) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
- D. The SPD shall be compliant with the Restriction of Hazardous Substances (RoHS) Directive 2002/95/EC.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Handle and store equipment in accordance with manufacturer's Installation and Maintenance Manuals. One (1) copy of this document to be provided with the equipment at time of shipment.

PART 2 – PRODUCTS

2.1 SPD REQUIREMENTS

- A. SPD shall be UL 1449 listed and labeled with 200kA Short Circuit Current Rating (SCCR). Fuse ratings shall not be considered in lieu of demonstrated withstand testing of SPD, per NEC 285.6.
- B. SPD shall be UL 1449 labeled as Type 1 or Type 2 intended for use without need for external or supplemental overcurrent controls. Every suppression component of every mode, including N-G, shall be protected by internal overcurrent and thermal overtemperature controls. SPDs relying upon external or supplementary installed safety disconnectors do not meet the intent of this specification.
- C. SPD shall be UL 1449 labeled with 20kA I-nominal (I-n) (verifiable at UL.com) as recommended UL 96A Lightning Protection Master Label and NFPA 780.
- D. SPD components shall be heavy duty 'large block' MOVs, each exceeding 30mm diameter.
- E. SPD shall provide surge current paths for all modes of protection: L-N, L-G, L-L, and N-G for Wye systems; L-L, L-G in Delta and impedance grounded Wye systems.
- F. SPD shall include a serviceable, replaceable module or modules (excluding Distribution).
- G. Service Entrance SPDs shall be equipped with the following diagnostics:
 - 1. Visual LED diagnostics including a minimum of one green LED indicator per phase, and one
 - 2. Audible alarm with on/off silence function and diagnostic test function (excluding branch).
 - 3. Form C dry contacts
 - 4. Optional – Surge Counter

No other test equipment shall be required for SPD monitoring or testing before or after installation.

Distribution Panels SPDs shall be equipped with the following diagnostics:

- 1. Visual LED diagnostics including a minimum of one green LED indicator per phase, and one
- 2. [Audible Alarm & Dry Contacts]

No other test equipment shall be required for SPD monitoring or testing before or after installation.

- H. If a dedicated breaker for the SPD is not provided in the switchboard, the service entrance SPD

shall include an integral UL Recognized disconnect switch. A dedicated breaker shall serve as a means of disconnect for distribution SPD's.

I. SPD shall meet or exceed the following criteria:

1. Minimum surge current capability (single pulse rated) per phase shall be:

a. Service Entrance and MCC applications:

1) SPD surge current capability shall be [200kA] per phase.

b. Distribution applications:

1) Maximum surge current capability of 100kA per phase.

2) UL 1449 Listed Voltage Protection Ratings (VPRs) shall not exceed the following:

VOLTAGE	L-N	L-G	N-G
208Y/120V	700V	700V	700V

J. UL 1449 Listed Maximum Continuous Operating Voltage (MCOV) for L-N, L-G, and N-G modes of protection (verifiable at UL.com):

System Voltage	Allowable System Voltage Fluctuation (%)	MCOV
208Y/120	25%	150V

K. SPD shall be complimentary UL 1283 listed for EMI/RFI filtering with minimum attenuation of -50dB at 100kHz.

PART 3 – EXECUTION

3.1 INSTALLATION

A. The installation shall meet the following criteria:

1. Install per manufacturer's recommendations and contract documents.
2. Install units plumb, level and rigid without distortion
3. One primary suppressor shall be installed external to the service entrance in accordance with manufacturer instructions.
4. Service Entrance SPD shall be installed on the line (Type 1 only) or load side of the main service disconnect.
5. Service Entrance SPD ground shall be bonded to the service entrance ground.
6. At Service Entrance or Transfer Switch, a UL approved disconnect switch shall be provided as a means of servicing disconnect if a 60A breaker is not available.
7. One SPD shall be installed external to each designated distribution panelboard.
8. At Distribution, MCC and Branch, SPD shall have an independent means of servicing disconnect such that the protected panel remains energized. A 30A breaker (or larger) may serve this function.
9. SPD shall be installed per manufacturer's installation instructions with lead lengths as short (less than 24") and straight as possible. Gently twist conductors together.
10. Installer may reasonably rearrange breaker locations to ensure short & straightest possible leads to SPDs.
11. Before energizing, installer shall verify service and separately derived system Neutral to Ground bonding jumpers per NEC.

3.2 ADJUSTMENTS AND CLEANING

- A. Remove debris from SPD and wipe dust and dirt from all components.
- B. Repaint marred and scratched surfaces with touch up paint to match original finish.

3.3 TESTING

- A. Check tightness of all accessible mechanical and electrical connections to assure they are torque to the minimum acceptable manufacture's recommendations.
- B. Check all installed panels for proper grounding, fastening and alignment.

END OF SECTION 26 0660

SECTION 26 07 31 WIRELESS CLOCK SYSTEM

PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS & SCOPE

- A. Furnish and install a complete new Wireless Clock System with Bell Scheduling System using the Primex XR Time Synchronization system and the Bell Scheduling system.
- B. Furnish and install all system devices, accessories, and material in accordance with these specifications and drawing to provide a complete and operating system.
- C. All bids shall be based on the equipment as specified herein. The model designations are that of Prime. The specifying authority must approve any alternate system
- D. System shall include the System Devices
 - 1. Transmitter (Master)
 - 2. Satellite Transmitter
 - 3. Analog Clocks

1.2 RELATED SECTIONS

- A. Division 26 “Electrical”

1.3 REFERENCES

System devices specified shall meet or exceed the requirements of the following:

- A. National Fire Protection Association (NFPA): 1. NFPA 70 - National Electrical Code (NEC).
- B. Manufacturer Installation and User Guides.

1.4 DEFINITIONS

- A. NTP: Network Time Protocol, used for synchronizing the clocks on computer networks and devices from either a public server or a separate server on a private local area network.
- B. UTC: Universal Coordinated Time

1.5 SYSTEM DESCRIPTION

- A. System shall continually wirelessly synchronize clocks and/or timers, and shall be capable of clock readouts in multiple time zones where desired.
- B. System shall operate on a 72MHz frequency. The 72MHz frequency transmitter efficiently sends time synchronization signals through commercial building materials to ensure all devices receive important time updates, even for Daylight Saving Time and after a power outage.
- C. The system transmitters can be configured with a variety of power output levels to provide coverage for a single building or an entire campus.
- D. The system supports an FCC license for operation of a 72MHz transmitter result in safe and interference free operation for users.
- E. System shall provide time data wirelessly from a master time source. This time source will be the clock from a defined NTP server that the system transmitter can access via the customer Local Area Network (LAN). The master time will be synchronized to UTC.
- F. Hard wiring for data communication will not be required to the clocks installed for the system.
- G. Clocks shall automatically adjust for Daylight Saving Time in locations where DST is observed.
- H. Each clock and/or timer and every other component in the system shall use both precise time and synchronized time.

- I. Analog Clocks shall be synchronized to within 10 milliseconds 6 times per day when operating clock strikes 2:01 AM, 6:01 AM, 10:01 AM, 2:01 PM, 6:01 PM, and 10:01 PM, and the system shall have an internal oscillator that maintains plus or minus one second per day between synchronization, so that clock accuracy shall not exceed plus or minus 0.2 seconds.
- J. The system shall include an internal clock reference so that failure to detect the master time source shall not result in the clocks failing to indicate time. Additionally, system transmitters will have an internal battery backup of up to eight hours in the event of a power failure so that settings and the correct master time will be instantly recalled upon restoration of power.
- K. System shall incorporate a “fail-safe” design so that failure of any component shall not cause failure of the system. Upon restoration of power or repair of failed component, the system shall resume normal operation without the need to reset the system or any component thereof.
- L. If transmitter stops transmitting valid time signals due to power failure, the clocks will continue to function as accurate quartz clocks until a valid time signal is decoded. If signal transmission is not restored after 48 hours, the second hand will “two-step” as a visual indicator that the signal has been lost. Should the clocks lose both power and signal, the clocks will not function.
- M. Clock locations shall be as indicated and clocks shall be fully portable, capable of being relocated at any time.
- N. System must operate in accordance with a “Radio Station Authorization”, Form FCC 601 – LM, granted by the Federal Communications Commission (FCC). This license will be issued to and held by the end user.

1.6 REGULATORY REQUIREMENTS

- A. Equipment and components furnished shall be of Manufacturer latest model.
- B. System shall be installed in compliance with local and state authorities having jurisdiction.
- C. The end user will hold a license, known as a “Radio Station Authorization” granted by the FCC. This license grants the end user protected use for wireless transmission at the designated frequency. This license will designate a unique “call sign” for each end user.
- D. Transmitter and receiver shall comply with Part 90 of FCC rules as follows: This device may not cause harmful interference. This device must accept interference received, including interference that may cause undesired operation. Transmitter frequency shall be governed by FCC Part 90.35. Transmitter output power shall be governed by FCC Part 90 257 (b).

1.7 SUBMITTALS

- A. Product Data: Submit complete catalog data for each system device and components, describing physical characteristics and method of installation.
- B. Samples: Submit one specified system device model(s) for approval. Approved sample(s) shall be tagged and shall be installed at location directed.
- C. Manufacturer Instructions: Submit complete installation, set-up and maintenance instructions.
- D. Floor plans indicating the location of system transmitter(s), approved by manufacturer, will be submitted to Owner prior to installation.

1.8 SUBSTITUTIONS

- A. Proposed substitutions, to be considered, shall be manufactured of equivalent materials that meet or exceed specified requirements of this Section.
- B. Proposed substitutions shall be identified not less than 10 days prior to bid date.
- C. Other systems requiring wiring and/or conduit between master and clocks and/or timers will not be accepted.

- D. Other systems using wireless technology in an unlicensed frequency range will not be accepted.
- E. Other systems using wireless technology where the license is held by any party other than the end user will not be accepted.
- 1.9 QUALITY ASSURANCE
 - A. Permits: Operating license for the transmitter from the FCC.
 - B. Qualifications: Manufacturer: Company specializing in manufacturing commercial time system products with a minimum of 30 continuous years of documented experience including 10 or more years of experience producing GPS wireless time systems. Manufacturer of wireless and Ethernet connected system with a minimum of seven years record of satisfactory manufacturing and support of systems comparable to basis of specified system design.
 - C. Installer: Company with documented experience in the installation of commercial time systems.
 - D. Prior to installation a site survey must be performed to determine proper transmitter placement.
- 1.10 DELIVERY STORAGE AND HANDLING
 - A. Deliver all components to the site in the Manufacturer original packaging.
 - B. Packaging shall contain Manufacturer name and address, product identification number, and other related information.
 - C. Store equipment in finished building and in unopened packaging until ready for installation.
- 1.11 PROJECT SITE CONDITIONS
 - A. Clocks and/or Timers shall not be installed until painting and other finish work in each room is complete.
- 1.12 SYSTEM START-UP
 - A. At completion of installation and prior to final acceptance, turn on the equipment; ensure that all equipment is operating properly, and that all system devices and components are functioning.
- 1.13 WARRANTY
 - A. Manufacturer will provide a 5-year limited warranty on system transmitters, clocks, digital timers, timer control switches, wireless tone generators, and GPS receivers.
 - B. All other system components shall have a 1-year limited warranty, including external antennas and components, wireless data receivers, universal power supply (UPS) backups, and bell controller devices.

PART 2 – PRODUCTS

- 2.1 SECTION INCLUDES
 - A. The system and equipment is specified as described in this section.
 - B. All bids shall be based on the equipment as specified herein. The model designations are that of Primex, Inc. The specifying authority must approve an alternate system.
- 2.2 MANUFACTURER
 - A. System shall be manufactured by:
Primex, Inc., 965 Wells Street, Lake Geneva, WI 53147 | Phone: (800) 537-0464 | Fax: (262) 248-0061 | Email: info@primexwireless.com | www.primexwireless.com
- 2.3 SYSTEM OPERATION
 - A. The system shall perform in the sequence of operation as described.
 - 1. Configure and install system appliance detailed in Manufacturer installation instructions.
 - 2. Configure and install system devices per model specifications detailed in Manufacturer

installation instructions.

B. Transmitter Operation

1. When power is first applied to the transmitter, it checks for and displays the software version. It then checks the position of the switches and stores their position in memory. The transmitter looks for the master time source.

C. Master Time Source Operation

1. NTP Time Source: With the transmitter in NTP mode, it connects over the Ethernet to the IP address of the NTP server. This IP address is programmed into the transmitter as part of its configuration. Once the connection to the NTP server is acknowledged, it downloads time data and synchronizes its internal master clock to NTP time. The transmitter then starts to transmit its internal time once every second. The transmitter updates its internal clock in this mode once per hour.

D. Clock and/or Timer Operation

1. After initial setup, the clock and/or timer will shut off the receiver. Six times each day an Analog Clock microprocessor will activate the receiver and starting with the stored channel it will again look for a valid time signal. Every 10 minutes a Digital Clock/Timer will activate the receiver and starting with the stored channel it will again look for a valid time signal. If necessary, the clocks will resynchronize to the correct time.
2. If an Analog clock has not decoded a valid time signal for a pre-determined number of days, it will go to a step mode. Low battery voltage is a common cause of the clock to not properly decode a time signal. If a clock goes into step mode, replace the batteries first and then determine if the clock synchronizes to master time source before attempting other troubleshooting methods.

2.4 EQUIPMENT

A. The system shall include all equipment as specified.

1. Transmitter Equipment

- A. Per specification, supply following model(s).

Model	Antenna	Time Source
1 Watt Transmitter (49 channel)	Internal	NTP or GPS

2. Transmitter 1 Watt

- a. 1-Watt maximum transmission (at transmitter)
- b. 72MHz frequency range
- c. 49 channels available (pre-programmed prior to shipping)
- d. Daylight Saving Time bypass switch
- e. Time zone adjustment switch (pre-programmed for transmitter with external antenna prior to shipping)
- f. LCD display for time, date, and signal verification
- g. Dimensions: 17.0”L x 12.0”W x 1.7”D (43.2cm x 30.5cm x 4.32cm)
- h. Power Supply: Input: 120 VAC, 50/60 Hz, 0.6 Amp | Output: 9 VDC, 2.78 Amp (6 ft. cord, 1.83m)

- i. Operating Range: 32° - 122°F (0° - 50°C)
 - j. Transmitter with Internal Antenna
 - Antenna: 46.0"L (116.8cm)
 - Weight: 7.75 lbs. (3.5kg)
 - Internal Antenna Model only: Transmitter shall transmit time continuously to all clocks in the system.
 - k. Internal clock: Transmitter shall contain an internal clock such that failure to update time from source will not disable the operation of the clocks.
 - l. Transmitter shall include a surge suppressor/battery backup and a mounting shelf.
 - m. Transmitter shall have the following switches
 - (1) Time zone adjustment switches for all time zones in the world. Includes: Eastern, Central, Mountain, Pacific, Alaska, and Hawaii.
 - (2) 49 channel transmitter - Switch to allow the following configuration: Daylight Saving Time bypass option, 12-hour or 24-hour display, GPS or NTP time source, Local or LAN configuration, UTC+ or UTC-, 30-minute UTC offset option CANADA (for Newfoundland).
 - n. Transmitter housing shall incorporate a display, which shall include the following:
 - (1) Time readout
 - (2) AM and PM indicator if 12-hour time display is set
 - (3) Day and date readout
 - (4) Time zone indicator including Standard or Daylight Savings Time
 - (5) On screen menu to verify diagnostics, errors, time updates, and switch settings, toggled by sequence of push buttons next to display.
 - (6) Status LEDs: The LED signal indicator consists of three visual LEDs that indicate the status of the transmitter. The green LED indicates one of the three statuses, including (1) solid green: transmitter is transmitting, (2) not illuminated: transmitter has not received an initial time signal after power up and/or reset, and (3) flashing: transmitter is not broadcasting due to standby mode or there is a condition that is causing the transmitter not to broadcast properly. The yellow LED indicates one of the two statuses, including (1) not illuminated: no warning conditions, (2) flashing: transmitter has not received a time update for 48 hours or a 1PPS (one pulse per second) has not been detected within the last 48 hours. The red LED indicates one status, (1) solid red: defined error condition exists.
3. NTP or GPS Time Source
- a. 49 channel transmitter will allow for either NTP time input or GPS satellite time input with use of a GPS Receiver unit. Unit shall obtain current UTC time from either satellite via GPS or via NTP through an Ethernet port.
4. Satellite Transmitter
- a. Satellite Transmitter shall receive the signal from a Wireless Receiver Switch and transmit the signal to the system devices in its vicinity, which are out of range from the system transmitter.
 - b. Transmitter shall include a wireless receiver switch, surge suppressor/battery backup, and mounting shelf.

- c. A 5-foot (1.52m) RS232 cable connects receiver switch to the satellite transmitter.
 - d. Antenna mounted on top of the switch housing, 12.5-inch L (31.75cm).
5. Analog Clocks
- a. Analog clocks shall be wall mounted.
 - b. Face shall be white. Hour and minute hands shall be black.
 - c. Additional colors, finishes, and dial faces are available from Manufacturer.
 - d. Clock faces can be customized by Manufacturer to display organization name or logo as specified.
 - e. Clock frames and lenses are of durable thermoplastic.
 - f. Clocks shall have a tamper proof/theft resistant clock-lock mounting slots.
 - g. Analog clocks shall be capable of automatically adjusting for Daylight Saving Time. An on-off switch located on the transmitter shall disable this function if desired.
 - h. Clock shall have either a battery-power or a 120 VAC power supply built into the clock assembly.
 - i. If power is interrupted, the clock will stop until power resumes. Upon resumption of power, the clock will self-correct to the current time.
 - j. Battery-operated analog clocks shall have up to a 5-year battery life. Battery life is based on common operating conditions and may vary due to installed site conditions.
 - k. Installer will furnish clock batteries in accordance with Manufacturer instructions.
 - l. Time shall be automatically updated from the transmitter 6 times per day.
 - m. If the transmitter stops transmitting valid time signals due to power failure, the clocks will continue to function as accurate quartz clocks until a valid time signal is decoded. If signal transmission is not restored after 96 hours, the second hand will “two -step” as a visual indicator that the signal has been lost. Should the clocks lose both power and signal, the clocks will not function.
 - n. Analog clock receivers shall be as follows: Receiver sensitivity: >-110 dBm, Receiver power: Dual Alkaline batteries or AC-powered, Antenna type: internal, Antenna gain: -7 dBd
 - o. **SUPPLY MODELS - Traditional Series Analog Clocks**
(Power Source) Description
(Battery) 12.5” (31.75cm) Black
(Battery) 16" (40.64cm) Black (Gym and Multi-Purpose Rooms)
6. Accessories
- a. **Analog Clock Wire Clock Guard**
Description:
16" Clocks (40.64cm): 18" square x 3"D (45.72cm square x 7.6cm D)
 - b. **1-Watt Transmitter Rack**
18 GA metal
Epoxy coated
18”L x 3”H x 16.5”D (45.7cmL x 7.6cmH x 41.9cmD)
Description

1-Watt Transmitter Rack

Transmitter accessory pack - transmitter Rack and UPS

Event Bell Controller Device

PART 3 – EXECUTION**3.1 EXAMINATION**

- A. Examine conditions with the Installer present for compliance with requirements and other conditions affecting the performance of the system and the system devices.
- B. Do not proceed until unsatisfactory conditions have been corrected.
- C. Verify that construction is complete in spaces to receive equipment and that rooms are clean and dry.
- D. Verify that 120-volt electrical outlet is located within 6 feet (1.83m) of location of transmitter and the outlet is operational and properly grounded.
- E. Code Blue and Elapsed Timer: Verify single gang electrical box for switch control is mounted and within 15 feet (4.5m) of elapsed timer. Verify pathway for connecting cable is available and compliant to local building codes.
- F. AC-powered devices: Verify that electrical power outlet is near location of clock or timer and the outlet is operational and properly grounded.

3.2 INSTALLATION

- A. General: Install system devices in accordance with applicable codes.
- B. Install system devices in accordance with Manufacturer written instructions.
- C. Provide all system equipment necessary for a complete and operable system.
- D. Clearance around all sides of the transmitter to comply with local building codes.
- E. If NTP will be used as master time source:
 - 1. Connect CAT6 EIA/TIA standard Ethernet cable from transmitter LAN port to available network drop.
 - 2. Set GPS/LAN DIP switch to NTP.
- F. Transmitter (INTERNAL Antenna Only)
 - 1. Local transmitter where indicated, a minimum of 2 to 3 feet (0.6 to 1 meter) above the floor, away from large metal objects, such as filing cabinets, lockers, or metal framed walls.
 - 2. Transmitter(s) will be placed at locations indicated within specifications and drawings.
 - 3. Connect antenna to transmitter, using care not to strip threads.
 - 4. Connect power supply to the transmitter.
 - 5. Set the channel number on the display to correspond to the FCC license.
 - 6. Plug power supply into electrical outlet.
- G. Analog Clocks
 - 1. Furnish all equipment necessary for a complete and operational system.
 - 2. Perform the following operations with each clock:
 - a. Configure and set clock to correct time in accordance with manufacturer instructions.
 - b. Observe clock until valid signals are received and clock adjusts itself to correct time.
 - c. Install each clock per its model mounting specifications per manufacturer instructions

and mounting instructions at the indicated location.

3.3 FIELD INSPECTION

- A. Inspection: Make observations to verify that system devices and components are properly labeled.
- B. Prior to final acceptance, inspect each system device and component, adjust as required, and replace parts which are found defective.
- C. At completion of system device installation and prior to final acceptance, turn on the equipment; ensure that all equipment is operating properly, and that the system software and all system devices and components are functioning.
- D. Wire Guards: Secure to wall, using approved theft-resistant fasteners.

3.4 MANUFACTURER SERVICES

- A. System software and system device installation and user guides shall be provided.
- B. If needed, provide technical assistance as demonstrated in the manufacturer guides, on product start-up and system set-up, to owners or installers representatives via phone, fax, or email.

3.5 CLEANING

- A. Prior to final acceptance, clean exposed surfaces of devices, using cleaning methods recommended by Manufacturer.
- B. Remove temporary labels from clock faces. Do not remove labels from backs of clocks.

3.6 DEMONSTRATION

- A. Provide training to Owner's representative on setting, adjusting, and configuring device and routine maintenance.
- B. Provide training to Owner's representative on installing the software, adjusting and programming the transmitter, setting and adjusting system devices and routine maintenance.

3.7 PROTECTION

- A. Protect finished installation until final acceptance of the project.

3.8 TESTING

- A. All devices must be tested at their operational installation location under normal operational conditions to ensure reception of signal.

END OF SECTION 26 07 31

SECTION 26 07 40
NETWORK CABLING SYSTEMS**PART 1 – GENERAL****1.1 GENERAL PROVISIONS**

- A. Refer to other sections for General Requirements, etc., which shall apply to the work specified in this section. The following specifications for network cabling are based on the Communications Cabling Construction Standards generated and implemented for all State of Delaware schools and was developed by the State of Delaware, Department of Technology and Information (DTI).
- B. In general, the network sub-contractor will furnish, install and test all cabling and terminations herein specified for distribution of the station/field wiring.
- C. The Electrical Contractor shall utilize one of the approved State of Delaware installing contractors as indicated on the State list. The contractors are approved for furnishing, installation and testing of the entire network. The contractor must be certified and authorized for the installation of premises cabling system and shall assume responsibility for certifying the installation and providing a warranty for a period of no less than 25 years.

1.2 SCOPE

- A. Perform all work necessary and/or required and furnish all materials and equipment for a complete network cabling system as described herein.
- B. The data communications system shall be installed, consisting of the following components:
 - 1. Optical fiber network backbone
 - 2. Twisted pair copper work station cabling
 - 3. Work station outlets
 - 4. Cable support system
- C. The MDF shall be connected to each IDF via a single, twelve- strand, composite, single-mode optical fiber cable. Each classroom and office data outlet shall be connected to its respective IDF via a four twisted-pair, Cat 6 data cables.
- D. The hardware shall include equipment racks, patch panels, station outlets, Cat 6 data cables, optical fiber cables, all required terminations required copper/fiber patch cables and labeling to provide for a complete data distribution system.
- E. In general, one or more data outlets shall be provided for each computer station in classrooms, library and in offices where indicated on floor plans. The teacher's station outlet located in each classroom shall have data/Voip, and audio cable connections.

1.3 SUBMITTALS

- A. Furnish shop drawings and descriptive data, complete with project designations for the following:
 - 1. Equipment Racks
 - 2. Patch Panels
 - 3. Station Outlets
 - 4. Cat 6 Data/Voip Cables
 - 5. Optical Fiber Cables – OS2 Single Mode
 - 6. Cable Support System
 - 7. Wire Management Materials
 - 8. Video cables as indicated in schedule on drawing.

9. Shielded Audio Cables

1.4 DOCUMENTATION

- A. The contractor shall provide a complete system walk-through, by suitably qualified personnel, to personnel designated by the owner, to instruct them on the installed system's location, operation and maintenance.
- B. Prior to assembly and installation, the contractor shall submit the following, on reproducible media, to the engineer for review
 - 1. Final schematic drawings of all circuitry, including outlet conductor assignments and all component callouts.
 - 2. Equipment modifications drawings.
 - 3. Front mechanical drawings of each equipment rack.
- C. At the completion of the installation, the contractor shall provide one (1) copy of each of the following:
 - 1. Equipment manufacturer's operation and maintenance manuals for each piece of equipment.
 - 2. "As-built" drawings for all equipment installed.
 - 3. "As-built" drawings on contract blueprints of all wire, cable and conduit placement throughout the building.
 - 4. "From-To" listing of in-building wiring and outlets, listing color coding scheme and conductor assignments.

PART 2 – PRODUCTS

2.1 DELAWARE STATE STANDARDS

- A. Authority: Title 29, Chapter 90C provides broad statutory authority to the Department of Technology and Information to implement statewide and interagency technology solutions, policy, standards and guidelines for the State of Delaware's technology infrastructure. "Technology" means computing and telecommunications systems, their supporting infrastructure and interconnectivity used to acquire, transport, process, analyze, store and disseminate information or data electronically. The term "technology" includes systems and equipment associated with e- government and Internet initiatives.
- B. Applicability: Applies to all State of Delaware communications and computing resources. DTI is an Executive Branch Agency and has no authority over the customers in Legislative and Judicial Branches, as well as school Districts, and other Federal and Local Government entities that use these resources. However, all users, including these entities, must agree to abide by all policies, standards promulgated by DTI as a condition of funding, access and continued use of these resources.
- C. Purpose: Cable configuration and installation is critical to providing connectivity in State buildings. This standard provides guidance for the design and installation of cabling. This standard provides guidance and requirements for data, voice, and CATV structured cabling systems and support infrastructure in all State owned and leased facilities and buildings.
- D. Scope
 - 1. Areas Covered: This standard covers the best practices and installation requirements for Voice, Data, CATV cabling and support structures including conduits and raceways, Voice and Data rooms and closets.
 - 2. Environments: This standard applies to all State owned and leased building and office spaces. It is concerned with all Data, Voice, and CATV cabling projects, whether they are for new construction or revisions additions and upgrades to existing systems.

E. Process

1. Adoption: These standards have been adopted by the Department of Technology and Information (DTI) through the Technology and Architecture Standards committee (TASC) and are applicable to all information Technology use throughout the State of Delaware.
2. Revision: Technology is constantly evolving; therefore, the standards will need to be regularly reviewed. It is the intent of the TASC to review each standard annually. The TASC is open to suggestions and comments from knowledgeable individuals within the State, although we ask that they be channeled through your Information Resource Manager (IRM).
3. Contractors: Contractors or other third parties are required to comply with these standards when proposing technology solutions to DTI or other State entities. Failure to do so could result in rejection by the Delaware Technology Investment Council. For further guidance, or to seek review of a component that is not rated below, contact the TASC at dti_tasc@state.de.us.
4. Implementation responsibility: DTI and/or the organization's technical staff will implement these best practices during the course of normal business activities, including business case review, architectural review, project execution and the design, development, or support of systems.
5. Enforcement: DTI will enforce these best practices during the course of normal business activities, including business case and architectural review of proposed projects and during the design, development, or support of systems. These best practices may also be enforced by others during the course of their normal business activities, including audits and design reviews.
6. Contact us: Any questions or comments should be directed to dti_tasc@state.de.us.

F. Executive Summary

1. Because of ever-advancing Industry Standards and new Alliances between Cable and Hardware Manufactures and Vendors, this document seeks to enhance and clarify the State of Delaware's wiring and cabling standards and specifications for Structured Cabling Systems. Approved Contractors under State of Delaware Contract # 05-441-TL are required to adhere to these specifications and standards.
2. The structured cabling system will support Voice, Data, and imaging applications within State-owned and - leased office facilities. This document describes the Structured Cabling System requirements to be met in the proposals for Communications cabling by Vendors and Contractors. These requirements encompass all materials, design, engineering, installation, supervision, and training services for a Structured Cabling System.
3. The following are examples of the Structured Cabling Systems that can be bid for new construction and whole building renovations, in which case all building structured cabling wiring is replaced. The choice of a Structured Cabling System is not limited to the Vendors or Manufactures listed below. The Channel Solutions shall be bid when possible. If a Link solution is bid the State Contact, PM, or DTI (Department of Technology and Information) must authorize the installation.
4. In new construction projects, the default cabling infrastructure shall be Category 6 unless specified otherwise. Where building renovations and additions do not require the removal of the existing structured cabling system, the existing cabling in conjunction with new cabling should maintain the system warranties. If the existing structured cabling system is not Category 5e or better, it must be upgraded to CAT6 or better with a matching patch panel.
 - Hubbell Premise Wiring
 - Ortronics

- Panduit
- Systimax

5. Terms and Conditions of Bids/quotes

- a. An approved Contractors bid submittal should be based on the materials, systems, equipment, and Standards described in this document and in the bid response format of the attached example. Refer to Appendix G. All bids must be submitted in accordance with the specifications and information contained herein, as well as with any addenda, if required.
- b. The bid package shall be accompanied by a presale warranty commitment, binding the Installation Contractor and Manufacturer to the customer-selected extended warranty package as described in State Contract # 05-441-TL page 21 section 3) paragraph b).
- c. At any point in time, should you require clarification or have any questions pertaining to the content of this document, please call The State of Delaware Department of Technology and Information (DTI). 302-739-9500.

G. Objective

1. This document has been developed as a source of information to assist in the design, implementation and maintenance of Voice, Data and Broad Band communications systems. It contains standards and specifications which guide users through structured cabling system design, planning, and installation.
2. To maximize the usefulness of this document, access to the various TIA/EIA (Telecommunications Industry Association/Electronic Industries Alliance), IEEE (Institute of Electrical and Electronics Engineers), BICSI, (Building Industry Consulting Service International), NEC (National Electrical Code), NFPA (National Fire Protection Association) Communications Standards, and implementation and installation Manuals for further reference is required. This document assumes that users have communications knowledge and training in all aspects of design, implementation, installation, and testing of a Voice/Data communications system.
3. This document does not address safety issues associated with use. It is the individual's responsibility to use established and appropriate safety and health practices and to determine the applicability of all regulations.

H. Credits

1. Communications Cabling Construction
 - a. Developed by:
State of Delaware
Department of Technology & Information
801 Silver Lake Blvd.
Dover, DE 19904
2. The content of this document is drawn from experience, as well as other documents and manuals, including the following:
 - NEC 2011/2013 Code book
 - NFPA-70 Publications
 - TIA/EIA Communications Building Wiring Standards
 - IEEE Publications & Standards
 - BICSI Communications Distribution Design and Installation Publications

- MOTOROLA R56 Standards and Guideline for Communications
- Various Manufactures Publications and Requirements

I. Introduction

1. Any Structured Universal Cabling System installed for the Agencies of the State of Delaware is designed to meet known and anticipated technology needs within the State. An advanced building cabling system provides for more than communication services; it provides an infrastructure for an institution's entire communications network. Instead of being a basic utility, it is as important as the high-tech systems that transmit signals over it and is an integral component of the State's overall information network.
2. These designs provide a universal and flexible cabling system for workstations, conference rooms, and laboratories. Today's cabling system must be multi- functional and provide service for telephones, computers, fax machines, LANs, WANs, broad band fiber optic and coaxial systems (CATV, SATV, CCTV.), Data Centers, computer-aided design workstations, Audio Video systems (AV), and other technologies. For a cabling system to be capable of meeting today's technology and institutional demands, it must have high bandwidth capacity and transmission speed while being extremely flexible.
3. This wiring architecture incorporates the applicable ANSI/EIA/TIA standards, BICSI guidelines and the latest technologies. This cabling distribution plan can integrate all types of systems from a variety of vendors. The design uses a subsystem approach, which allows for changes in the system without affecting other parts of the system. The Main Distribution Frame (MDF) and Intermediate Distribution Frame (IDF) Room equipment racks are designed to allow for growth, and the cable routing is accomplished through the provision of cable trays, conduits, sleeves, raceways, and cable hangers where required. Ease of administration and recordkeeping for moves and changes is readily apparent, as is the flexibility that a structured cabling system provides.
4. The wiring medium for the Communications Cable Network consists of Category 6+– 6a 24AWG Unshielded Twisted Pair (UTP) for station cabling and multi pair twisted copper for backbone cabling to support low- speed voice or Data, Category 6+ or 6a for high speed LAN technologies, and 50/125 micron multi-mode fiber optic cable and 50/125 micron multi-mode as well as single mode 8.3/125 micron for even higher bandwidth requirements. The unshielded twisted pair (UTP) Category 6+ or 6a LAN cables can support Data transmission rates of 100, 250 and 500 up to 1000Mb/Sec respectively according to EIA/TIA Standards and manufacturers' specifications.
5. These leading edge components, combined with the open wiring architecture, provide the technology, flexibility, and modularity that allow the system to grow and change to meet changing needs.
6. The central distribution location of the system is the Fiber Optic, coaxial and Copper Main Distribution Frame (MDF) located within the centrally located MDF/IDF Room of each building. Various fiber optic, coaxial and copper riser cables terminate on the MDF and extend to the Communications Rooms/Closets (IDFs) located throughout the buildings. Each building typically has one MDF/IDF Room and a varying number of IDF rooms/closets dictated by the horizontal station cabling limitation of 100 meters for high performance cable. The distance from the information outlet to the termination within the IDF is limited to 90 meters (the permanent link). The IDF room/closet houses the Intermediate Distribution Frame (IDF), Copper and Fiber Optic IDF Patch Panels, Local Area Network (LAN) equipment, and other electronics. Both the riser cables and the horizontal station cables feeding the floor's workstations information outlets terminate in the IDF on Data patch panels, Voice 110 hardware, and Fiber Optic Patch Panels. These termination points act as the cross-connect

7. Each work area and workstation is served by an information outlet, which provides the jacks for plugging in telephones, computers, broad band coaxial systems, fax machines, modems, and other devices at the desktop. The information outlets are served by varying sets of cables consisting of fiber optic and copper technologies, which originate in the IDF Room. IDF outlets are typically displayed as varying types of triangles (shaded, half-shaded, etc.) on blueprints. (See figure 2)
8. A subsystem architectural approach, using the latest technologies, provides a comfortable level of assurance that the system will support new applications and industry standards as they emerge.

FIGURE 1

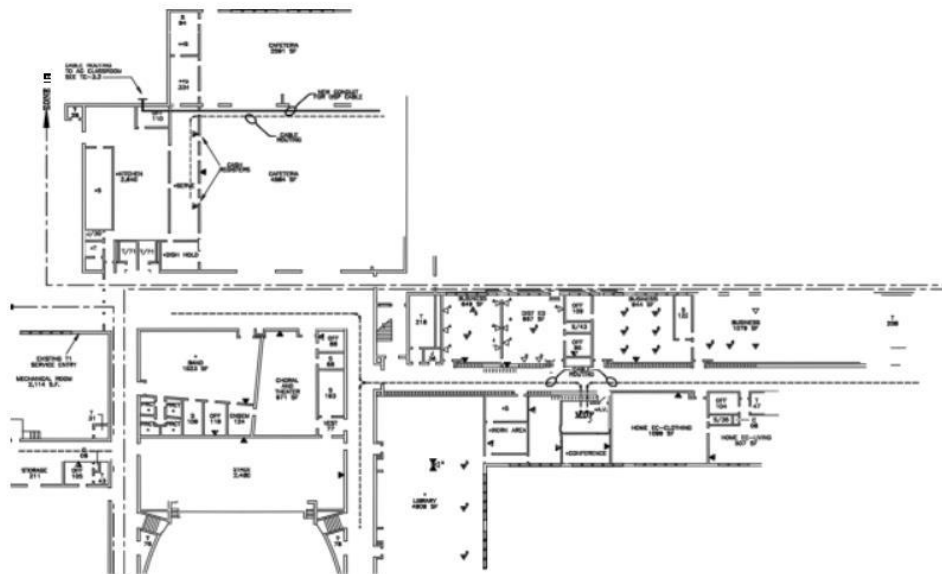
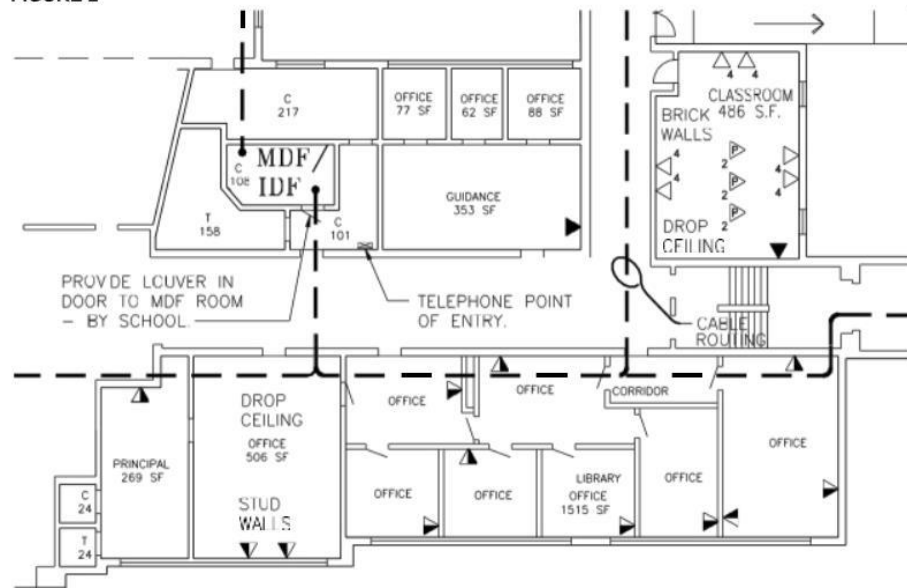


FIGURE 2



J. Procedures

1. Designing a cable system for an institution involves various organizations and individuals and requires a great deal of coordination. Once an institution is designated for wiring, AutoCAD drawings of the floor plans need to be acquired. AutoCAD is a type of computer aided drafting (CAD) format. These files are plotted and converted to blueprints that serve as the working drawings for site surveys and engineering purposes. Based on interviews with the agency's staff and Technical Coordinator will draw triangles on the drawing displaying the locations that information outlets are to be located. Also, tentative locations for the Communications/Data rooms/closets will be marked on the drawings. This information will be approved by the institution's officials and sent to the engineering team.
2. The engineers will survey the building—floor plans for new construction—and evaluate the communications rooms/closets, plan cable routing, and review the information outlet locations. The necessary adjustments will be made during the site survey, and the engineer will leave the site with the proper approvals from the agency's management if there are major changes such as room relocations.
3. The engineering team will then design the cable system for the building. The end product will be submitted to the agency's Technical Coordinator for comment and/or revision. If no adjustments are necessary, the blueprints are issued to the contractor for construction.

K. Horizontal Distribution System

The horizontal structured cable plant is the portion of the communications wiring system that extends from the information outlet to the Communications/Data room/closet.

1. Horizontal Distribution System General
 - a. The horizontal distribution system includes the:
 - Information outlet at the workstation
 - Cables connecting the workstation to the Communications/Data room/closet
 - Intermediate routing and distribution systems
 - b. The horizontal distribution system should be configured in a star topology. All communications outlets within a work area should be connected to a single

Communications/Data room/closet, as defined by the zone concept.

- c. This infrastructure must serve all of the Communications requirements of the agency or owner.
 - d. Communications applications served by the horizontal system can include:
 - Voice (e.g., telephones)
 - Data (e.g., terminal connectivity, modems, etc.)
 - Local area networks (e.g. Ethernet)
 - Audio & Video (e.g., CATV, video conferencing and security monitoring)
 - Graphics & Imaging
 - e. When designing a horizontal distribution system, include capacity to satisfy long- term requirements as well as initial plans. Ensure that the distribution system has the flexibility to accommodate necessary moves, additions, changes, and system growth.
 - f. After construction, the horizontal distribution system is typically difficult to access. Therefore, the time, effort, coordination, and skills required for changes can be extremely costly. In addition, access to the horizontal distribution system frequently causes disruption to the user community.
 - g. All Horizontal Workstation Communications and broad band coaxial system cabling will be home- run" from the information outlet location to the termination point within the corresponding IDF or MDF/IDF room.
 - h. Horizontal cable paths will be in a "streets and avenues" manner, typically following main walkways.
 - i. Horizontal cables are to be fastened onto hangers five feet apart with all cables bundled with tie wraps, and are to have a small amount of slack visible.
 - j. Cables must be supported by its own support system and not rest on any structures or the hung ceiling. Cables are not to be fastened to ducts, pipes, conduits, or any other existing structures. Cable bundles should be secured to the slab overhead to avoid any conflict with or EMI from flexible electrical conduits, transformers, motors, etc. (Follow the TIA-EIA 569-D.2 Pathways requirements)
 - k. Some cabling shall run to workstation and other outlets through cavities in the dry wall and openings in sheet metal or wooden studs within the dry wall construction. The sheet metal studs will not have gaskets for this purpose, so it is the Contractor's responsibility to exercise extreme care in snaking cable through these areas, so as to avoid damage to the cable jacketing.
 - l. The building's horizontal wiring plan is to be installed on all floors from the information outlet to the termination point within the associated IDF Room.
 - m. Horizontal cable will be installed onto "J" hooks (similar to B-Line BCH series) or equivalent in the ceiling or tops of walls near ceiling. Cables are to be fastened to "J" hooks or equivalent every 5 feet. The cable contractor is to provide and furnish the "J" hooks.
 - n. All station cable (horizontal) and tie cables that run from relay racks to the wall- mounted frames are to be plenum-rated.
2. Horizontal Communications Cable Specification
- a. For each type of information outlet indicated on the attached drawings, the contractor shall furnish all of the following equipment, install it in the correct configuration, and test it.

- b. All cabling, outlets, and termination patch panels used for the Category 6 data system must be provided by a single manufacturer and shall be certified as part of the 25 year minimum warranty- Where the installer chooses to use one (1) manufacturer for cabling and a different manufacturer for the outlets and termination patch panels for the Category 6 data system, the two (2) manufacturers must prove to have compliant interconnecting hardware and shall be certified as part of the 25 year minimum warranty.
 - c. All Category 6 UTP & Fiber cabling is to be handled and terminated in accordance with the Manufacturer's Premises Communications Application and Installation Guide.
 - d. In addition to the above manufacturer's standards, all applicable ANSI/TIA/EIA-568-C Category 6 and Fiber Optic Cable standards are to be strictly adhered to.
 - e. The fiber optic cable is to be terminated on both ends with an LC type connector on the patch panels.
 - f. The contractor is to use Plenum cable for all station 4-pair copper, and 12-strand fiber cabling.
 - g. Plan routes to ensure that the proposed route on the plans falls within the EIA/TIA distance limitations (90 meters after termination) for horizontal cabling.
 - h. Cables serving information outlets that cannot be routed down wall cavities will be enclosed in latching surface-mount raceways, anchored (not with adhesives) to walls. Contractor will provide all raceway fittings to allow for level and plumb routes from ceiling to information outlet. Proper fill ratios must be observed. Contractor may reference the manufacturer's catalogs or specifications for correct fittings and fill ratios. Contractor must use all accessory fittings required in order to build a neat and functional installation. This same method will apply to routing horizontal cables to workstation outlets where ceilings are not accessible.
 - i. The IDF Room side of the Category 6a four-pair cables serving a standard outlet will be punched down on individual 110 (Category 6) modular patch panels, 568B wired. The patch panels will be mounted in the relay racks within the IDF rooms.
 - j. The contractor is to install vertical cable management on the side of all racks.
 - k. In locations that have wall-mounted racks, the rack should be hinged to swing out to access the back of patch panels with associated cable management.
 - l. Contractor is to label both the front and the rear of the patch panels. The terminations are to follow this sequence: Workstation 001A, 001B, 002A, 002B. It is acceptable to change numbering for floor or closet designation.
3. Zones
- a. A zone is a contiguous area in which all horizontal wiring is homed to a single communications closet within 90 meters from the IDF.
 - b. To maintain an orderly, understandable wiring system, it is imperative that the horizontal distribution system be structured in zones.
 - c. Within a zone, all communications wiring is run to a single communications closet.
 - d. Other zones use different Communications/Data rooms/closets. Cross-zone horizontal wiring is prohibited. Connections between zones are provided via the vertical distribution system.
- L. Communications/Data Rooms/Closets (General)
- 1. The Communications/Data room/closet is a concentration point for communications and LAN services. In this room, premise wiring and cabling are terminated and cross-connected.

- In addition, active networking devices such as switches are placed here. Communications/Data rooms/closets provide a safe area for housing distribution cabling, premise equipment, and termination fields. These rooms/closets are a focal point for communications services.
2. In addition to supporting in-house connectivity, the MDF Communications/Data room/closet often provides a termination point for the local telephone company. The entrance facility, or demarcation point (de-mark), is the location where outside communications services, such as copper telephone lines, fiber optic Data circuits, and CATV, are delivered to the building. Typically, distribution of communications services within the building originates at this point and is the responsibility of the owner.
 3. Special considerations must be given when providing the building entrance pathways for the copper, fiber optic, and coaxial cables that service providers will install in to the building de-mark. It is the owner's responsibility to provide this pathway into the building. Contact DTI for standards and specifications for building entrances.
 4. The following section details the basic requirements for a Communications/Data room/closet. It may be used to assist in:
 - Designing new Communications/Data rooms/closets
 - Assessing and refining existing Communications/Data rooms/closets to support evolving communications requirements.
 5. Design Guidelines: The suggested building practices put forth in this section are recommendations and are subject to field conditions and budget constraints. Local building and electrical codes, practices and requirements may supersede the guidelines presented in this section.
 - a. Sizing of Communications/Data rooms/closets
 - The Communications/Data room/closet must have enough space to support required communications systems, including projected growth.
 - The existing system is likely to be replaced in the future
 - A new system may, require more (or less) space
 - The existing system and a new system may need to coexist during a cut-over
 - b. Location of Communications/Data rooms/closets
 - Communications/Data rooms/closets should be situated so as to minimize the length and the quantity of cable runs needed for the distribution systems.
 - The maximum horizontal distribution cable distance must be less than 90 meters (295 ft.), independent of media type. This distance represents the cable length from the mechanical termination of the media in the Communications/Data room/closet to the outlet in the work area. This is known as the permanent link.
 - Vertical (backbone) distribution system distance limitations vary and are dependent upon media, topology, and facility issues.
 - c. Unacceptable locations for Communications/Data rooms/closets:
 - Anywhere water vapor exists, such as boiler rooms, washrooms, or janitor's closets.
 - Spaces with corrosives, explosives, and combustibles, including acid, ammonia, chlorine, oxygen, and petroleum vapors.
 - Spaces containing steam pipes, drains, or clean-outs.

- Areas with high traffic volumes (for security reasons, as well as to minimize the risk of inadvertent damage) unless separately enclosed.
- Areas of high electromagnetic interference (EMI) or radio frequency interference (RFI). Both adversely affect system performance and reliability.

6. General Room Requirements

a. Electrical

- All active Communications, Data and Video systems have specific electrical power requirements. Plan electrical service to ensure smooth installation, reliable service, and compliance with manufacturers' warranties. Be sure to consider equipment manufacturer's specifications, National Electric Code (NEC) requirements, State and local codes, ordinances, and requirements.
- Electrical devices capable of causing line transients, such as fans, pencil sharpeners, radios, calculators, and lights, must be separated electrically from the Communications equipment. To accomplish this, all Communications and Data equipment requires separate electrically isolated ground circuits and/or building grounding. The outlets on these circuits should be labeled and/or color coded. Frequently, orange-colored wall outlets are used to identify power sources used for computing and communications equipment. Utility outlets are also needed in the Communications/Data room/closet for tools, test sets, and other equipment.
- Each Communications/Data room/closet shall have one 110V, 15 Amp electrical convenience outlet and one 110V, 20 Amp dedicated-circuit electrical outlet for the electronic equipment. This is a minimum requirement based on the typical current draw of the networking equipment to be placed. The 110V 20 Amp dedicated circuit isolated ground electrical outlet(s) should be mounted in convenient location to facilitate the use of the shortest equipment power cords. The recommended location is at the top of the rack or on the ladder tray.
- All electrical isolated ground outlets serving Communications and Data equipment must be attached to non-switched circuits to prevent inadvertent equipment shutdown. It is also recommended that they be on a UPS and/or generator if available.

b. Grounding

- Most Communications and Data equipment requires bounding and grounding of equipment cabinets. Do not use plumbing or conduit (EMT) fixtures as a ground source. Grounding shall meet the NEC and EIA/TIA requirements and practices except where other authorities or codes impose more stringent requirements or practices. (Refer to NEC Chapter 2 article 250 and Chapter 8 Communications Systems, TIA/EIA Standard J-STD-607-D and Motorola R56 Standards and Guideline for Communication site).
- In addition to protecting personnel and equipment from hazardous voltages, the grounding system may reduce the effect of electromagnetic interference (EMI) throughout the structured cable plant. Improper grounding can result in induced currents that disrupt Communications circuits.
- Ensure that the installation conforms with applicable regulations and practices
- Ensure that each Communications/Data room/closet has an appropriate ground buss bar
- Ensure that grounding is available for cross-connect frames, patch panel racks, Telephone and Data equipment, as well as testing and maintenance equipment

- c. Space
 - A distance of three feet is the preferred clearance from the front, back, and side of a relay rack.
 - If there are space constraints, it is acceptable to provide a minimum of two feet of clearance on one rack side for access and a minimum of two feet of front and back clearance for cross-connect fields, patch panels, etc. If possible, locate sleeves, cores, slots, and/or conduits together in one area to maximize usable wall space.
- d. Rooms/Closets Sizing
 - Determine the number of relay racks required for the termination of patch panels and electronic equipment. Assume that free-standing relay racks will be installed and provide three feet of space on all sides of each.
 - Determine the amount of wall space that will be required for the installation of termination equipment. A minimum of four feet should be used as a criterion.
 - Determine if the plywood backboard will be furred-out. This equals approximately 4" of space taken from the room.
 - Take into account the door swing if the door opens into the room. Ideally the door should open out from the room.
 - Determine how much space any sleeves, conduits, or other equipment require.
 - Determine the size of the room by constructing a diagram, to scale, of all of these components, taking into account all the walkways and door swings.
 - If a very small number of information outlets are being installed, the minimum size a closet can be is 4' wide and 3' deep. This assumes a 4' X 8' X 3/4" plywood backboard, one wall-mounted relay rack that has a fiber optic patch panel, copper patch panels, coax patch panel, LAN hubs and ground buss bar. It is recommended to install plywood on all walls, from the floor to the ceiling.
- e. Structural Walls
 - Extend from the floor to the deck above (fire wall)
 - Be securely fastened to the floor and the deck above
 - Conform to national and local construction guidelines
- f. Wall Linings
 - Each Communications/Data room/closet will contain a minimum of one furred-out or flush sheet of plywood (4' X 8') mounted on the wall.
 - It is recommended to install plywood floor to ceiling on all walls.
 - Securely fasten the plywood to wall framing members to ensure that it can support any attached equipment.
 - The plywood is to be 3/4", A/C grade, and fire-retardant.
 - All plywood backboards are to be mounted smooth side out and painted white at time of installation, prior to installation of equipment onto the plywood.
- g. Floor Finish
 - Keep dust to a minimum in Communications/Data rooms/closets.
 - Anti-static Asphalt Tile, Linoleum Tile, or Sealed Concrete is acceptable floor finishes.
- h. Ceilings and Doors

- Dropped ceiling height should be at least nine feet from the finished floor to provide adequate space for equipment cabinets and suspended cable trays. Some equipment may require additional height, depending on the manufacturer's specifications. Avoid installing false ceilings in small closets.
- Overhead ceiling vents should be centrally located to maximize air distribution and maintenance access. Avoid placing overhead ceiling vents directly over suspended racks and equipment cabinets.
- All ceiling vents should have diffusers (vent manifolds) securely installed.
- Design doorways with minimum measurements of 36 inches wide. Hinge the doors to open outward.
- All Communications/Data rooms/closets should have door locks and a minimum number of windows, if any. Closets should be kept locked. Provide keys to select personnel who are on- site continuously.

i. Lighting

- Within ceilings, position light fixtures at least eight feet above the finished floor.
- Indirect (reflected) lighting is not recommended.
- If possible, minimize heat and glare by using fluorescent light fixtures with protective covers instead of incandescent fixtures.
- Do not place light fixtures where the light may be blocked or filtered.
- Typically, light fixtures should not be directly above or within 12 inches of cabling, equipment cabinets, termination frames or other free-standing equipment.
- Install light fixtures on power circuits separate from those used for communications equipment.

j. Communication/Data Room/Closet Environment

- Manufacturers of most hardware recommend a room environment consisting of a temperature between 72–75° Fahrenheit and a 45–50% humidity level.
- It is recommended that temperature swings do not exceed 10° and humidity remain within a $\pm 5\%$ range.

7. MDF Requirements

- a. An MDF Room is a specialized communications closet that may house major communications systems, such as a communications processor, switch and routing equipment. The MDF Room is generally considered to be distinct from an IDF Room because of the complexity of the equipment it contains.
- b. A typical Main Distribution Frame (MDF) Room is composed of a wall-mounted plywood backboard and relay racks designed for mounting termination equipment and electronics (see Figure 3). Most MDFs within the building cabling system also serve as an IDF. This is accomplished by providing separate relay racks for each and delineating the wall-mounted frame's 110 blocks for Station cabling (see Figure 4 and Figure 5).

FIGURE 3

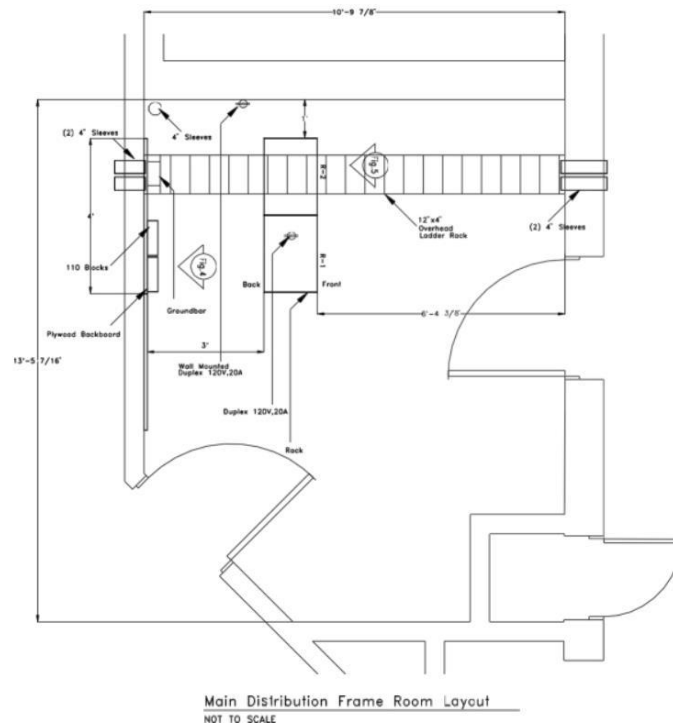


FIGURE 4

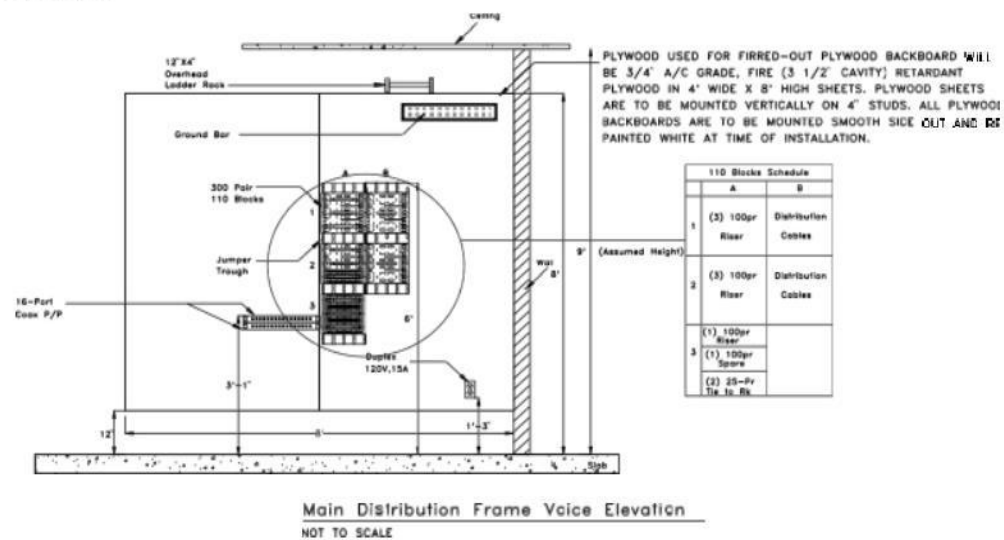
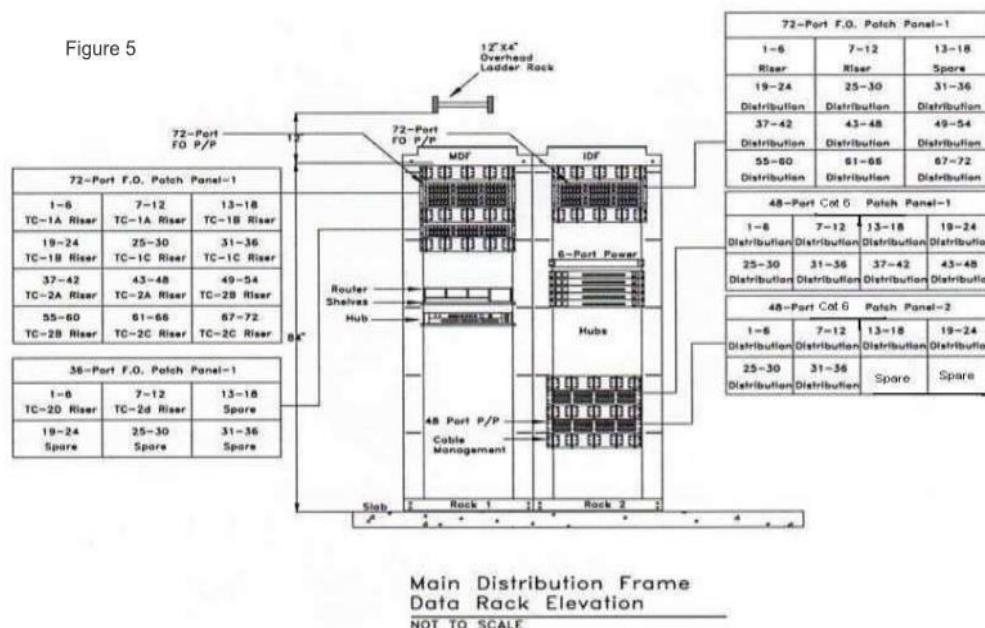


Figure 5



c. MDF/IDF Room Equipment Enclosures

- Any MDF/IDF Rooms located in rooms that are shared with space used for any other purpose should have wire mesh cages or sheetrock walls around the Communications equipment, or the equipment should be installed in a lockable cabinet.

d. Environment

- Environmental control equipment must function properly at all times. If the building system cannot ensure continuous operation on weekends and holidays, provision of stand-alone control units for the MDF/room and IDF room/closet is necessary.
- Within the MDF room and IDF room/closet, temperature should not vary by more than 5°F, and humidity must not vary by more than 10%. Measure temperature and humidity five feet above the finished floor in the center of the communications room/closet.

e. Local Exchange Carrier (LEC)

- Placement of Communications equipment may be influenced by vendors and service providers. For instance, the LEC (local phone company) may decide to terminate the Central Office (CO) service directly into the equipment space provided or request termination space other than that offered by the customer. If they request termination at a point other than that requested by the customer, the LEC should provide reasonable explanation.
- The LEC, CATV, and most service providers will require a conduit entrance in to the building to provide their service. The minimum requirements are two (2) four-inch conduits for the LEC and one (1) four-inch conduit for each other service provider, unless they specify otherwise in writing.
- It is critical that the high speed Data line, TLS – Canoga Perkins and Fiber Optics be located in the MDF room. This will ensure security and simplify troubleshooting.
- The LEC may also need space for distribution systems terminations (either horizontal or vertical) and patch cable terminations.

f. Other Equipment Vendors

- As with the local phone company (LEC), it is vital to consult with all Communications equipment manufacturers for their specific space and operational requirements, such as the telephone system and Data LAN/WAN equipment provider.

g. Relay Racks

- Each MDF will contain one 4-post server rack, model Ortronics, mm10 and two 2-post racks, model Hubbell HUB84RR19 onto which the fiber optic/copper patch panels and Data electronics are mounted.
- Each rack shall have vertical cable management of the Hubbel YM1013 or district approved equivalent.
- The relay racks should have a minimum of 45 rack units of mounting space on standard 19" wide rails.
- In some cases, the relay racks are wall-mounted and in others they are free-standing two- or four-post racks. It must be determined which type of rack is required, based on field conditions, equipment manufacturer's requirements, and space allocated.
- All racks are to be grounded and bolted to each other as well as to the slab or wall.
- The rack should have vertical and horizontal cable management to accommodate routing of patch cords.
- There should be a minimum distance of 48" to be maintained from three sides of the rack.
- The relay rack specifications and associated components should meet the requirements of the equipment that will be installed in it.
- It should be at a minimum 84" tall with 6" rails, with 19" equipment mounting space and vertical and horizontal wire management.
- Manufactured by Hubbell of Eaton/B-Line, Panduit or approved equivalent

h. Wall-mounted Relay Racks

- The rack is to be securely fastened to the wall behind it and attached to the ladder rack above.
- The rack should be sized to accommodate the equipment to be installed in it, with vertical and horizontal jumper management.
- Manufactured by Hubbell of Eaton/B-Line, Panduit or approved equivalent

i. Communications Cabinets

- All communications cabinets are to be grounded to the grounding and bounding system and bolted to each other and to the slab.
- Each communications cabinet is to be installed with its side to an adjacent wall. Three feet of clearance around the cabinet is recommended and the cabinets must have front and rear.

j. Data Equipment Cabinets

- Data equipment cabinets should conform to the State Data Center Standard as follows:

Cabinet size	30"Wx44.30'Dx79.'H
Rack units	42 rack units for equipment mounting

Mounting rails	Two pair 19" adjustable depth universal mounting
Mesh steel doors	Single front and split rear with locking handles
Vertical cable	Trough, rings or VeLCro tie downs or combination of, mountable management left or right side
PDU mounting	Space to mount two horizontal PDU closest to equipment mountable top or bottom, together or separate
PDU Metering	Managed or Metered PDU's to display Amperage, Voltage
Side panels	Removable, solid, both sides
Top	Solid with cabling access opening capabilities
Bottom if required	Solid with cabling access opening capabilities
- Cabinet should have grounding, bounding and anti-tip capabilities that can be added when required.
 - Approved cabinet Manufacturer: Eaton Wrightline RS Series or approved equal

k. Cable Trays

- Between the relay rack and the wall-mounted frame, a 12" cable tray (center-rail systems are not permitted), with a 4" load depth and 6" rung spacing is to be installed suspended from a ceiling support structure, mounted to the relay rack and the wall.
- Do not attach any cable tray to a suspended ceiling grid.
- An open wire basket cable tray system is acceptable for cable support.
- Approved manufacturer: Cooper B-Line part # FT4X12X10 or approved equal

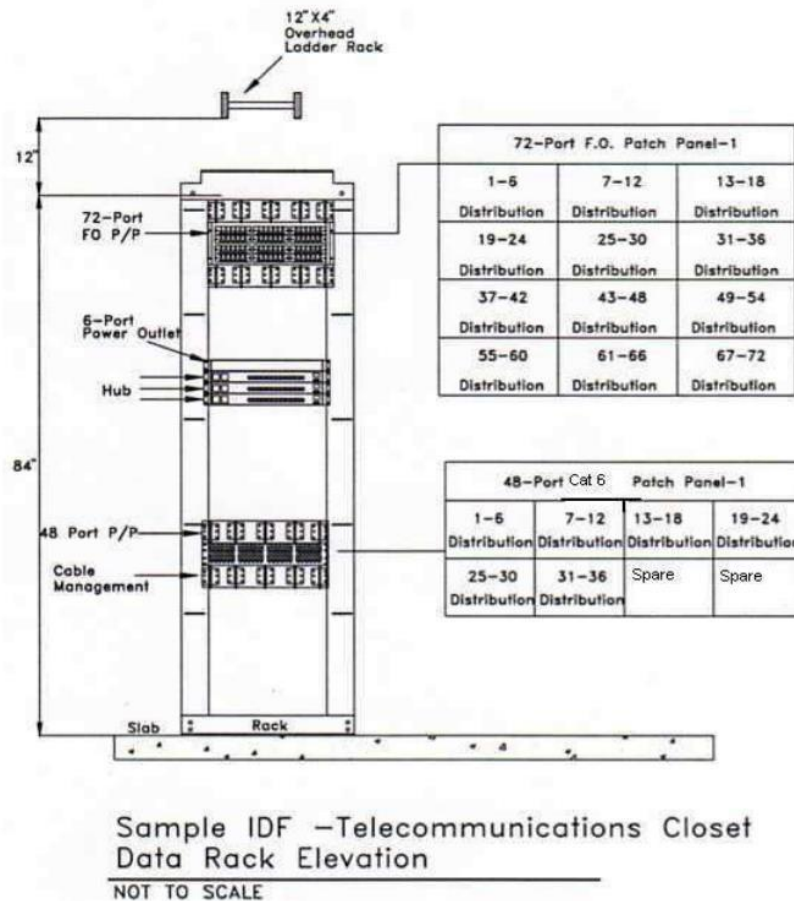
l. MDF Room Electrical Requirements

- Each room shall have a minimum of one duplex dedicated 20 Amp isolated ground circuit and one shared 20 Amp circuit.
- Larger equipment loads may require additional circuits.

8. IDF Room Requirements

- a. Each IDF Rooms within a building supports all connections in single, contiguous area (zones). Cross-zone wiring is not to be installed from user workstations. Connections between zones are made through backbone wiring systems, which link the IDF Rooms to the MDF. A typical Intermediate Distribution Frame (IDF) Room is composed of a wall-mounted plywood backboard and relay racks designed for mounting termination equipment and electronics.

FIGURE 8



- b. Number of IDF Communications/Data rooms/closets within a building
 - Each floor should have at least one IDF Communications/Data room/closet.
 - Wiring workstations to IDF Communications/Data rooms/closets on different floors is not a preferred practice but can be done if no alternative exists.
 - If possible, IDF Telecommunication Closets should be positioned toward the center of the building (usually the core area) and stacked vertically, when possible, in multi-story buildings.
- c. Plywood Backboard
 - Each IDF Room will contain a minimum of one 4' X 8' sheet of plywood flush-mounted on the wall.
 - Securely fasten the plywood to wall-framing members to ensure that it can support attached equipment.
 - The plywood is to be 3/4", A/C grade and fire retardant.
 - All plywood backboards are to be mounted smooth side out and painted with white fire-retardant paint at time of installation and prior to installation of equipment onto the plywood.
- d. IDF Room Equipment Enclosures
 - Any IDF Rooms located in rooms that are share space used for any other purpose

should have wire mesh cages or sheetrock walls around the Communications equipment.

e. Relay Racks

- Each MDF will contain a minimum of one 19"W X 7'H Relay Rack onto which the fiber optic/copper patch panels and Data electronics are mounted.
- Each rack shall have vertical cabling management of type Hubbell VM1013 or District approved equivalent.
- The relay racks should have a minimum of 42 rack units of mounting space on standard 19" wide rails.
- In some cases the relay racks are wall-mounted and in others they are free-standing two- or four-post racks. It must be determined which type of rack is required, based on field conditions, equipment manufacturer's requirements, and space allocated.
- All racks are to be grounded and bolted to each other as well as to the slab or wall.
- The rack should have vertical and horizontal cable management to accommodate routing of patch cords.
- The relay rack specifications and associated components should meet the requirements of the equipment that will be installed in it.
- It should be at a minimum 84" tall with 6" rails, with 19" equipment mounting space and vertical and horizontal wire management.
- Manufactured by Hubbell or Eaton/B-Line, Panduit or approved equivalent

f. Wall-Mounted Relay Racks

- The rack is to be securely fastened to the wall behind the rack and attached to the ladder rack above.
- The rack should be sized to accommodate the equipment to be installed in it, with vertical and horizontal jumper management.
- Manufactured by Hubbell or Eaton/B-Line, Panduit or approved equivalent

g. Communications Cabinets

- All communications cabinets are to be grounded to the grounding and bonding system, bolted to each other and to the slab.
- Each communications cabinet is to be installed with its side to an adjacent wall.
- Three feet of clearance around the cabinet is recommended, and the cabinets must have front and rear access.

h. Cable Trays

- Between the relay rack and the wall-mounted frame, a 12" cable tray (no center rail systems), with a 4" load depth and 6" rung spacing is to be installed suspended from a ceiling support structure, mounted to the relay rack and the wall.
- Do not attach cable trays to the suspended ceiling grid.
- An open wire basket cable tray system is acceptable for cable support.
- Manufactured by Hubbell or Eaton/B-Line, Panduit or approved equivalent

i. IDF Room Electrical Requirements

- Each Communications/Data room/closet shall have one 110V, 15 Amp electrical convenience outlet and one 110V, 20 Amp dedicated-circuit, isolated-ground electrical outlet for the electronic equipment.

- This is a minimum requirement based on the typical current draw of the networking equipment to be placed.
- The ground for the equipment outlet should be isolated where possible to avoid line transients.
- The 110V 20 Amp dedicated-circuit, isolated-ground electrical outlets should be mounted in convenient location to facilitate the use of the shortest equipment power cords.
- The recommended location is at the top of the rack or on the ladder tray.
- All electrical isolated ground outlets serving Communications and Data equipment must be attached to non-switched circuits to prevent inadvertent equipment shutdown.
- It is also recommended that they be on a UPS and/or generator if available.

M. MDF & IDF PRODUCT SPECIFICATIONS

1. Category 6 Patch Panels: In new construction projects, the default cabling infrastructure shall be Category 6 unless specified otherwise.
 - a. Category 6 Patch Panel Requirements
 - Category 6 patch panels shall be standard 8-position, RJ-45 style, un-keyed, in 48-port configurations.
 - Panel frames shall be 14-gage steel with rolled edges top and bottom for proper stiffness.
 - Panel design shall incorporate plastic push-fasteners to permit hands-free positioning onto standard EIA-310-D 19" mounting rails.
 - Panels shall accommodate a minimum of 24 ports for each rack mount unit (1 RMU = 1.75 in.).
 - Panels shall be designed for 4-pair, 100 ohm balanced unshielded twisted pair (UTP) cable.
 - Panels shall terminate 26-22 AWG solid conductors, with maximum insulation diameter of 0.050 in.
 - Panels shall have attached wiring instruction labels to permit either T568A or T568B wiring configurations.
 - Panels shall have individual port identification numbers on the front and rear of the panel.
 - Panel adapter modules shall be 110-style termination with tin lead solder plated IDC contacts.
 - Printed circuit boards shall be fully enclosed front and rear for physical protection.
 - Panel contacts shall withstand a minimum of 2000 mating cycles with an FCC 8-position RJ-45 plug, without degradation of electrical or mechanical performance.
 - Panel contacts shall be constructed of Beryllium copper for maximum spring force and durability.
 - Contact plating shall be a minimum of 50 micro-inches of hard gold in the contact area over 50 micro-inch of nickel.
 - Panel termination method shall follow the industry standard 110 IDC punch-down, using a standard 110 impact termination tool.

- Panels shall be compatible with a 4-pair multi-punch impact termination tool designed specifically for the purpose. Bending or other damage to the panel using a multi-pair punch tool shall not occur.
 - IDC contact termination towers shall have tapered pair-splitting features to aid wire insertion and minimize pair un-twist.
 - IDC contacts shall be Phosphor Bronze with 100 micro-inch tin lead 60/40 plating over nickel.
 - Panels shall not require special cords or special installation requirements.
 - Panel ports shall accept optional hinged dust covers and port identification icon buttons.
 - Space above the adapter ports shall be available for additional labeling per ANSI/TIA/EIA-606-A.
 - Category 6 panels shall be backward compatible with existing Category 3, 5, and 5e cabling systems for fit, form, and function.
 - Panels shall accept a clip-on rear cable management support bar to provide cable strain relief.
- b. Category 6 Patch Panel Performance Requirements
- All transmission performance parameters shall be independently verified by a UL or ETL third party testing organization.
 - Category 6 panels shall meet or exceed Category 6 transmission requirements for connecting hardware, as specified in ANSI/TIA/EIA-568-C.2 Transmission Performance Specifications for 4-Pair 100 ohm Category 6 Cabling.
 - The manufacturer shall provide Category 6 component compliance certificates from third party testing organizations upon request.
 - Panels shall be UL LISTED 1863 and CSA certified.
 - Panels shall support 4PPOE IEEE 802.3bt Power specification to 1.5 times the rated current limits with no degradation of performance or materials.
 - Panel contacts shall withstand a minimum of 2000 mating cycles with an FCC 8-position RJ-45 plug, without degradation of electrical or mechanical performance.
 - Panels shall be third party verified, error free Gigabit Ethernet performance to IEEE 802.3 standard.
 - Category 6 panels shall meet the current draft 10 Gb/s performance requirements of IEEE 802.3an and TSB-155, for a maximum 55-meter channel length. Conditions of requirement No. 10 above apply.
- c. Acceptable Manufacturers:
- Hubbell Premise Wiring: The Hubbell products listed in the table below comply with all requirements specified in this document
- | HUBBELL
CATALOG NUMBER | Description |
|---------------------------|---|
| P6E48U | NEXTSPEED® Category 6 Patch Panel, 48-Ports |
| PCBLMGT | Rear Cable Management Bar |
- Or approved equal of: Ortronics, Panduit, Systimax.
- d. Category 6 Patch Panel Installation Requirements

- Horizontal and backbone cabling of the proper category shall be fully deployed into the TR, TE, or ER according to applicable codes and standards.
- Cable slack, service loops, bend radii, and pathway fill ratio shall comply with applicable codes and standards.
- Racks, cabinets, enclosures, and metallic cable pathways shall be bonded to an approved ground according to ANSI-J-STD-607-A.
- Cable ends for termination shall be clean and free from crush marks, cuts, or kinks left from pulling operations.
- Properly mount patch panels into the designated rack, cabinet, or bracket locations with the #12-24 screws provided.
- Terminate cables into the patch panel according to manufacturer's instructions.
- To maximize transmission performance, maintain wiring pair twists as close as possible to the point of termination.
- The length of wiring pair un-twist in each termination shall be less than 0.5 inches (13 mm).
- Horizontal or backbone cables extending from the panel terminations shall maintain a minimum bend radius of at least 4 times the cable diameter.
- Cable terminations shall have no tensile or bending strain on panel IDC contacts in each installed location.
- Panels shall be properly labeled on front and back with the cable number and port connections for each port.

2. Fiber Enclosures, Adapter Plates, Connectors

a. Fiber Adapter Enclosure Requirements

- Enclosure design shall be a modular, rack-mounted, powder coated formed cold rolled steel enclosure with a removable front cover, rear panel, top panel, and slide-out inner tray.
- Each basic unit delivered shall consist of: (1) enclosure assembly, (2) mounting brackets, (6) cable ties, (5) snap-in cable clips (4) #12-24 mounting screws, (1) adhesive grid label, (4) adhesive cable clips, (2) Velcro cable ties, (3) label holders, and (1) splice tray stud, wing nut, and spacer.
- Material shall be as follows:
 - (1) Enclosure, panels and tray: 16-gauge cold rolled steel (CRS)
 - (2) Mounting brackets: 14 gage CRS
 - (3) Front cover: Acrylic (Plexiglas)
- Basic dimensions of the enclosures shall be approximately 17" wide by 12" deep.
- Enclosures shall be available in heights of 3.5" (2 RMU), 5.25" (3 RMU), and 7" (4 RMU) versions.
- Finish shall be black durable powder coat on all surfaces.
- Front door shall be Lexan plastic, hinged at the bottom, with a cap-plugged hole to accept an optional lock. Front door shall also be removable in the fully open position by sliding left off the mounting pins.
- Front door shall be secured in the closed position with magnetic quick-release latches.

- Top cover shall be removable in the forward direction, without fasteners, to provide access to the connector field. Top panel shall also have knockouts for backbone cable entry.
- Rear panel shall be removable without fasteners.
- Enclosure shall be equipped with panel-mounting brackets assembled for 19" rack mounting, compliant to ANSI/EIA-310-D.
- Panel mounting brackets shall be configurable to either 19" or 23" racks.
- Enclosure chassis shall have two mounting bracket locations for either flush mount or center mount on the rack.
- Rear of enclosure shall have two knockouts, top and bottom, for backbone cable entry and internal routing.
- Front of enclosure chassis shall have side cutouts for patch cord entry into, and exit from the enclosure.
- Inner tray shall slide out in the forward direction by releasing the lever-action quick-release latches. Tabs in the chassis shall engage with slots in the inner tray in the outward position to prevent tray from falling out.
- Inner tray shall have rear-located knockouts to match rear chassis knockouts.
- Inner tray panel mounting posts shall accept modular adapter panels, in high- or low-density versions. Adapter panels shall be available in singlemode.
- Splice tray mounting boss shall also accept a stud for mounting blown fiber adapter brackets.
- Inner tray shall have clips for cable ties, and holes to accept snap-in cable clips, front and rear, for complete cable management of patch cords and distribution cable strands.
- Inner tray shall have rear cable tie-down features to accept various diameter backbone cables entering the enclosure.

b. Fiber Adapter Panels Requirements

- Fiber adapter panels shall be a modular, quick-fastening steel plate, powder coated to match the enclosure finish.
- Fiber adapter panels shall have pre-installed LC fiber adapters, available in low- or high-density multi-mode or single-mode applications.
- Each individually bagged unit delivered shall consist of: (1) fully assembled adapter panel, with push-pull fasteners pre-installed.
- Adapter panels shall be constructed of 16-gauge cold rolled steel.
- Finish shall be black durable powder coat on all surfaces.
- Basic dimensions of the FSP panels shall be 5.10" length by 1.10" wide.
- Panels shall have two pre-installed, push-pull type quick-release fasteners for quick snap-in installation. Push-pull fasteners shall have an industry standard center distance of 4.65".
- Panels shall be suitable for mounting either vertically or horizontally.
- Panels shall be available in with LC adapters with precision ceramic alignment sleeves.
- All fiber adapters installed in FSP panels shall have dust caps installed.

- Panels shall be available in low-density and high-density adapter patterns.
- c. Fiber Connector Requirements
 - Please note OM4 minimum standard
 - (1) Internal Building Installation
 - (a) Each IDF will connect back to the MDF with 12 strands of SM fiber.
 - (2) External Building/Campus Installation
 - (a) Buildings less than 1640ft/500m shall use a mix of Single Mode fiber.
 - (b) Installation distances GREATER than 1640ft/500m require use of Single Mode fiber exclusively.
 - Connector basic design shall be a factory pre-polished LC optical fiber connector with a zirconium ceramic ferrule. Integral with the connector body is a wedge-activated fiber clamping mechanism to secure the inserted fiber into a mechanical splice with the factory installed cleaved fiber stub. Index-matching gel is supplied factory-injected into the cleaved fiber stub splice to optimize transmission performance. Connector attachment is achieved without tools, by inserting a field-cleaved optical fiber and then extracting the disposable clamp wedges from the connector body.
 - Each basic connector unit delivered shall consist of: (1) connector body with disposable clamp wedge, (1) strain relief boot, and (1) plastic dust cap.
 - Connector termination method shall utilize an industry standard multi-layer strip tool and bare fiber cleave tool as the only field tools required.
 - LC connectors shall have features to enable field verification using a Visual Fault Locator (VFL) during termination.
 - Connector materials shall be designed with thermal stability to comply with environmental requirements of ANSI/TIA/EIA-568-B.3 and TelCordia GR-1081-CORE.
 - Singlemode pre-polished fiber connector materials shall be as follows:
 - (1) Ferrule: zirconium ceramic
 - (2) LC inner body: thermally stable injection molded thermoplastic
 - (3) Dust Cap: nylon or PVC
 - (4) Strain relief boot: UL94-V0 molded PVC
 - Pre-polished LC connectors shall require no field polishing.
 - Colors for specific applications, as designated below:
 - Pre-polished OM4 LC connectors shall require no adhesives for termination.
 - LC connector internal fiber clamping mechanism shall firmly secure both the inserted glass fiber and the 900 micron buffer layer of the inserted fiber for maximum strain relief.
 - All standard mating and interface dimensions for LC connectors shall comply with ANSI/TIA/EIA-604-10 (FOCIS 10).
 - Ferrule outside diameter for LC singlemode connectors shall be 1.2483mm to 1.2497mm.
 - LC ferrule tip shall have a PC spherical radius of approximately 7.0 mm radius for singlemode versions.

- Delivered connectors shall be individually bagged with the dust cap installed to protect from contamination.
 - Delivered connectors shall have the disposable clamp activation wedge element pre-installed onto the connector body.
 - Connector design and termination technique shall be independent of cable type or manufacturer, and shall be compatible for either 900-micron buffer or 250-micron buffer distribution cables.
 - LC connector strain relief boot shall be a TeLCordia style slotted design for maximum flexural strain relief.
 - Strain relief boot shall be yellow for singlemode.
 - LC connectors shall be available individually bagged in packs of 12.
 - Pre-polished LC fiber connectors, when properly installed onto qualified cable, shall meet the 10 Gb/s Ethernet performance requirements of IEEE802.3.
 - Pre-polished LC fiber connectors, properly installed onto qualified cable, shall exceed the mechanical and environmental performance requirements of ANSI/TIA/EIA-568-C.3, Annex 'A'.
 - Pre-polished LC fiber connectors, properly installed onto qualified cable, shall exceed the mechanical and environmental performance requirements of TeLCordia GR-1081-CORE.
 - Qualification test data shall be available from the manufacturer upon request.
- d. Acceptable Manufacturers:
- Hubbell Premise Wiring: The Hubbell products listed in the table below comply with all requirements specified in this document.

HUBBELL CATALOG NUMBER	Description
FCR2U6SP	Fiber Enclosure - 2U Rack Mount Fiber Enclosure, Accepts 6 Adapter Panels
FCR2U9SP	Fiber Enclosure - 2U Rack Mount Fiber Enclosure, Accepts 9 Adapter Panels
FCR3U12SP	Fiber Enclosure - 3U Rack Mount Fiber Enclosure, Accepts 12 Adapter Panels
FCR4U15SP	Fiber Enclosure - 4U Rack Mount Fiber Enclosure, Accepts 15 Adapter Panels
FSPLCDS6	Fiber Adapter Panel - 6 LC Duplex, Blue for SM – Zirconia Ceramic Sleeves
FSPLCQS3	Fiber Adapter Panel - 6 LC Quad Blue for SM – Zirconia Ceramic Sleeves
FCLC900KSM12	Fiber Connector - LC, SM, 9/125 UPC – Blue Box of 12

- Or approved equal of: Ortronics, Panduit, Systimax.
- e. Fiber Installation Requirements
- For FCR-series enclosures, remove top and rear covers, and front door.

- Punch out the desired knockouts for cable entry.
- Using proper method, pull cables into cabinet through the desired knockout entry location.
- Strip the outer sheath and sub sheaths of the fiber cable to provide at least (2) meters service loop of the individual buffered fiber strands.
- Anchor the outer cable sheath into the rear channel of the inner tray using the cable ties provided. Note: in FCR-series enclosures, leave enough slack in the main cable to allow free motion of the inner tray fully outward. Remove cable entry knockouts as required.
- Installed copper and fiber cabling shall be properly strain relieved. Cable service coil, bend radius, and pathway fill ratio shall comply with applicable codes and standards.
- Use the plastic adhesive-backed clips provided to form the fiber strands into a large service coil on the surface of the inner tray. For FCR-series enclosures, be sure the inner tray has full mobility in and out, with no cable kinks or snags.
- Close inner tray and front cover, and lock the quick-release fasteners.
- Install LC fiber adapter panels by firmly using push fasteners to lock in place.
- Leave dust caps installed in the fiber adapter plates until connector termination is performed.
- Follow manufacturer's termination instructions for pre-polished connectors as specified
- Uncoil the 900-micron buffered strands of cable from the service loop and set-up for termination.
- Un-package the connector, and leave dust cap installed. Firmly press downward on the connector wedge tab to fully seat clamp wedges.
- Slide the strain relief boot onto the fiber strand before stripping.
- Using a fiber strip tool, strip buffered fiber completely to approx. 1.0" of exposed glass fiber.
- CAUTION: Do not nick or Scrape the glass fiber with the strip tool.
- Wipe the glass fiber firmly with an alcohol wipe. Always use 99.9% pure reagent grade alcohol for fiber cleaning.
- Mark the 900-micron buffer layer from the strip-off point per instructions.
- Insert the fiber into the cleave tool and cleave the fiber to the specified length from the end of the 900-micron buffer layer. Always keep the cleave tool clean.
- CAUTION: Always dispose of glass fiber waste in an approved container.
- Gently insert the cleaved fiber into the connector body. Rotate connector slightly during insertion to fully seat the fiber into the internal splice.
- Hold the seated fiber in place using slight force to form a bow in the fiber.
- CAUTION: Do not allow the installed fiber to slip backward.
- While holding the fiber seated, squeeze the wedge holder device to activate the clamp, and then slip the wedge holder off the connector body. Dispose the wedge holder.

- Remove the connector dust cap and inspect the ferrule tip. A 400X microscope is recommended. View of the polished fiber should be a smooth round circle with no scratches, pits, cracks or chips. Use a lint-free wipe to clean off any contamination.
- CAUTION: Do not view ends of live fibers, with or without a microscope.
- Plug the connector into the proper adapter panel and proceed with the next connector. Leave dust cap installed if the connector is not mated.

3. Racks, Horizontal & Vertical Managers

a. Equipment Racks Requirements

- Racks shall be a structural aluminum construction, having two 6-inch deep rails.
- Racks shall feature universal side mounting hole pattern for vertical cable managers.
- Racks shall feature a weight load capacity of 1,000 lbs. when properly secured to the floor.
- Each basic rack delivered shall consist of: (2) vertical rails, (2) base angles, (1) assembly hardware kit, (2) top angles, and (20) #12-24 dog point machine screws for panel mounting.
- Racks shall be available in either for 19-inch standard rack configurations.
- Tapped holes in the front and rear vertical rails for mounting of panels shall be #12-24 thread size. Powder coat shall not interfere with thread fit.
- Standard rack heights of 8 ft (96 in)
- Racks with heights of 8 ft shall have a capacity of 51 rack mount units
- Rack base angles shall be pre-drilled for floor mounting, and for assembly to vertical rails.

b. Horizontal Managers Requirements

- Horizontal Managers shall be 19"W, 3.5"H
- Horizontal managers shall be 16ga. Cold rolled steel construction with (6) pass thru holes, and (7) Front mounted 3.5" steel rod D-Rings.
- Horizontal managers shall have hinged Aluminum front cover to conceal patch cords.

c. Vertical Managers Requirements

- Vertical cable managers shall be 14"D, 10"W
- Vertical cable managers shall feature a steel rod construction for increased air flow.
- Vertical cable managers shall feature a solid aluminum door that is designed to open left or right and swing out of way for cable management.
- Vertical cable managers shall feature power strip mounting brackets on rear of manager.
- Vertical cable manager shall accept and include (16) 3" black cable management spools.

d. Acceptable Manufacturers:

- Hubbell Premise Wiring: The Hubbell products listed in the table below comply with all requirements specified in this document
- Cooper B-Line: The Cooper B-Line products listed in the table below comply with all requirements specified in this document

HUBBELL CATALOG NUMBER	Description
HPW84RR19D	84"H, 6"D Equipment Rack
HM24C	2U Horizontal Manager w/ 3.5" Front rings and cover
VM1013	Vertical Cable Manager, 14"D, 10"W, with door & cable spools

B-Line CATALOG NUMBER	Description
SB55608419U6	84"H, 6"D Equipment Rack
SB87019S2FB	2U Horizontal Manager w/ 3.5" Front rings and cover
SB860810S084	Vertical Cable Manager, 14"D, 10"W, with door & cable spools

- Or approved equal of: Ortronics, Systimax

N. INFORMATION OUTLETS – DATA & VOICE

1. A work area has at least one standard Information Outlet consisting of Data RJ45 jack. All of the RJ45 jacks shall be Category 6 unless otherwise specified and wired according to the 568B standard.
 - DATA & VOICE Cabling Requirement LCenarios
 - DATA PC & VOIP Telephony INFORMATION OUTLET
 - 1x DATA RJ45 CAT 6 Jack per Information Outlet
2. Information Outlet Locations
 - a. The location of the information outlets is dependent on the environment in which the outlets will be installed. An office environment certainly is different than a laboratory, training room, or manufacturing area. If the outlets are to be wall-mounted, the bottom of the outlet is to be located 15" above of the finished floor under normal conditions. However, there are many exceptions to this rule. If there is existing equipment that does not allow for this, such as a credenza or countertop, the outlet must be placed at a height appropriate to the situation.
 - b. Locate the outlet where it is closest to the equipment and people it will serve. Keep in mind that the cord from the outlet to the device can be a trip hazard or may span across doors. In an office environment, each desk or workstation should have an information outlet. If a particular area has a series of fax machines or modems, then additional outlets should be installed. The number of jacks in an outlet is standard, so to maintain the standard, additional information outlets of the same configuration should be installed; do not install non-standard outlets.
 - c. Computer laboratories or training rooms require a large amount of connectivity in odd locations. Power poles are one solution as is the use of surface-mounted raceway or floor-mounted boxes. Each situation is different and must be considered individually. Again, standards are to be maintained in outlet configurations.
 - d. When locating an outlet, consideration should be given to the route the cable must take to the information outlet. If the outlet is to be installed on a masonry wall and surface-mount raceway is used for cable routing, the location of the outlet may be more dependent on the path available down or across the wall than where the equipment is located. Each

location must be looked at individually to determine if the route to the desired outlet location is possible.

- e. Wall-mounted outlets should not be located on heating units, equipment or ductwork. They are always to be located on either a gypsum, sheetrock, or masonry wall.
 - f. A description of the information outlet configurations follows:
 - (1) Standard Office Information Outlets consist of: as detailed on the drawings attached to the contract, the contractor will install and terminate four-pair UTP Category 6 for Data cable onto individual RJ45 female jacks.
 - (2) Wireless Access Point consist of: as detailed on the drawings attached to the contract, the contractor will install and terminate four-pair UTP Category 6 for Data cable onto individual RJ45 female jacks.
3. Category 6 Jacks: In new construction projects, the default cabling infrastructure shall be Category 6 unless specified otherwise.
- a. Category 6 Jack Requirements
 - Jacks shall be standard 8-position, RJ-45 style, un-keyed, FCC compliant.
 - Jacks shall be designed for 4-pair, 100 ohm balanced unshielded twisted pair (UTP) cable.
 - Each jack shall be single unit construction, with snap – fit to industry standard keystone opening (.760” x .580”).
 - Jack housings shall fully encase and protect printed circuit boards and IDC fields.
 - Modular jack contacts shall accept a minimum of 2000 mating cycles without degradation of electrical or mechanical performance.
 - Jack contacts shall be constructed of Beryllium copper for maximum spring force and durability.
 - Contact plating shall be a minimum of 50 micro-inches of hard gold in the contact area over 50 micro-inch of nickel.
 - Jack termination method shall follow the industry standard 110 IDC punch-down
 - Jacks shall be compatible with a 4-pair single punch impact tool designed specifically for the purpose.
 - IDC contact termination towers shall have tapered pair-splitting features to aid wire insertion and minimize pair un-twist.
 - Jacks shall terminate 26-22 AWG solid or stranded conductors.
 - Jacks shall terminate insulated conductors with outside diameters up to .050”.
 - Jacks shall not require special cords, specialty tools or special installation requirements.
 - Jacks shall include a translucent stuffer cap for wire retention and to permit visual inspection.
 - Stuffer cap shall have retention snaps to assure conductor strain relief.
 - Jacks shall accept FCC compliant 6 position plugs.
 - Jacks shall accept optional hinged dust covers.
 - Jacks shall be compatible with ANSI/TIA/EIA-606-A color code labeling.
 - Jacks shall accept snap-on icons for specific identification.
 - Jacks shall be available in various colors to meet specific customer applications.

- Jacks shall have attached wiring instruction labels to permit either T568A or T568B wiring configurations.
 - Category 6 jacks shall be backward compatible with existing Category 3, 5, and 5e cabling systems for fit, form, and function.
- b. Category 6 Jack Performance Requirements
- All transmission performance parameters shall be independently verified by a UL or ETL third party testing organization.
 - Category 6 jacks shall exceed Category 6 transmission requirements for connecting hardware, as specified in ANSI/TIA/EIA-568-B.2-1, Transmission Performance Specifications for 4-Pair 100 ohm Category 6 Cabling.
 - Category 6 jacks shall exceed 10 Gb/s transmission requirements for connecting hardware, under the constraints of ANSI/TIA-TSB-155 (current draft).
 - The manufacturer shall provide Category 6 component compliance certificates from third party testing organization upon request.
 - Jacks shall be UL LISTED 1863 and CSA certified.
 - Jacks shall exceed IEEE 802.3 DTE Power specification to 4 times the rated current limits with no degradation of performance or materials.
 - Jacks shall be third party verified, error free Gigabit Ethernet performance to IEEE 802.3 standard.
 - Jacks shall exceed 4 Gb/s data transmission capacity within the bandwidth of 1 – 250 MHz when configured in a 4-connector channel.
 - Jacks shall exceed the 4-connector channel performance requirements of Category 6, per the ANSI/TIA/EIA-568-B.2-1 standard.
 - Jacks shall exceed the 4-connector Category channel performance requirements for 10 Gb/s transmission over Category 6, according to TIA/TSB-155 (current draft).
 - The 4-connector channel test configuration shall utilize Category 6 patch panels and Category 6 patch cords, from the same manufacturer, with qualified Category 6 cable.
- c. Acceptable Manufacturers:
- Hubbell Premise Wiring: The Hubbell products listed in the table below comply with all requirements specified in this document

HUBBELL CATALOG NUMBER	Description
HXJ6xx	NEXTSPEED® Category 6 Jack

xx = Jack color. Replace xx with “W” for White, “BK” for Black, “B” for Blue, “GY” for Gray, “GN” for Green, “OW” for Office White, “OR” for Orange, “R” for Red, “Y” for Yellow. Refer to project drawing for color applications.

- Or approved equal of: Ortronics, Panduit, Systimax.
- d. Category 6 Jack Installation
- Horizontal cabling of the proper category shall be fully deployed from the TR or TE to each wall plate location according to applicable codes and standards.
 - Cable slack, service coil, bend radii, and pathway fill ratio shall comply with applicable codes and standards.

- Metallic horizontal cable pathways shall be bonded to an approved ground according to ANSI-J-STD-607-A.
- Cable ends for termination shall be clean and free from crush marks, cuts, or kinks left from pulling operations.
- Terminate jacks according to manufacturer's instructions.
- To maximize transmission performance, maintain wiring pair twists as close as possible to the point of termination.
- The length of wiring pair un-twist in each termination shall be less than 0.5 inches (13 mm).
- Cable ends for termination shall be clean and free from crush marks, cuts, or kinks left from pulling operations.
- Properly mount patch panels into the designated rack, cabinet, or bracket locations with the #12-24 screws provided.
- Terminate cables into the patch panel according to manufacturer's instructions.
- To maximize transmission performance, maintain wiring pair twists as close as possible to the point of termination.
- The length of wiring pair un-twist in each termination shall be less than 0.5 inches (13 mm).
- Jacks shall be properly mounted in plates, frames, or housings with stuffer cap fully installed over IDC contacts.
- Horizontal cables extending from mounted jacks shall maintain a minimum bend radius of at least 4 times the cable diameter.
- Cable terminations shall have no tensile or bending strain on IDC contacts after assembly of faceplate or housing to the wall outlet.
- Jacks shall be tested as part of the installed horizontal cabling system, with faceplates assembled complete and properly mounted.
- Each link or channel in the horizontal cabling system shall be identified and tested individually, using an industry standard level III tester with correct settings.
- Each jack shall be tested as part of the horizontal channel or link for the parameters listed below.

4. Face Plates

a. Face Plate Requirements

- Faceplates shall be constructed of high impact, UL94 V-0 rated thermoplastic.
- Faceplates shall be 2.75" W x 4.5" H (69.8 mm x 114.3 mm) for single gang and 4.5" X 4.5" (114.3 X 114.3 mm) for double gang.
- Port size in each faceplate shall be industry standard vertical keystone opening size (.760" x .580").
- Faceplates shall accept Hubbell XJ-series UTP jacks and Snap-Fit fiber optic, audio, and video modules for multimedia applications.
- Faceplates shall provide for ANSI/TIA/EIA-606-A compliant workstation outlet labeling.
- Faceplates shall be provided with clear plastic and color-matched label field covers.

- Color-matched blank Snap-Fit modules shall be available separately to fill unused ports and openings as required.
 - Two #6-32 pan head Phillips/slotted mounting screws shall be included with each single gang faceplate.
 - Four #6-32 pan head Phillips/slotted mounting screws shall be included with each double gang faceplate.
 - Jacks and Snap-Fit modules shall snap firmly into rear of faceplate and position flush to outer plate surface.
 - Faceplates shall be compatible with standard NEMA openings and boxes.
 - Faceplates shall be compatible with raceway fittings, surface mount boxes, service fittings, flush mount boxes and drywall rings.
- b. Acceptable Manufacturers:
- Hubbell Premise Wiring: The Hubbell products listed in the table below comply with all requirements specified in this document

HUBBELL CATALOG NUMBER	Description
IFP11xx	1-Gang, 1-Port IFP Face Plate
IFP12xx	1-Gang, 2-Port IFP Face Plate
IFP13xx	1-Gang, 3-Port IFP Face Plate
IFP14xx	1-Gang, 4-Port IFP Face Plate
IFP16xx	1-Gang, 6-Port IFP Face Plate
IFP26xx	2-Gang, 6-Port IFP Face Plate
IFP29xx	2-Gang, 9-Port IFP Face Plate
IFP212xx	2-Gang, 12-Port IFP Face Plate

xx = Face Plate color. Replace xx with “W” for White, “BK” for Black, “GY” for Gray, “OW” for Office White, to project drawing for color applications.

- Or approved equal of: Ortronics, Panduit, Systimax.

O. CABLE ROUTING SYSTEMS

1. Each cable routing system has advantages and disadvantages. Particular systems are favored for a variety of reasons, including architectural considerations, appearances, cost, local ordinances, and material concerns.
2. Various means of distributing cable from Communications/Data rooms/closets to the user work areas are identified in the following:
3. Ceiling Distribution System
 - a. A distribution system within an accessible area above a false ceiling. This could either be a plenum area (where there is no enclosed system for cable routing) or an overhead conduit system (which has defined areas of access and routes).
4. “J” Hooks
 - a. Where not installed in conduits, cable trays, or other supporting devices, the horizontal wiring plan is to be installed onto “J” hooks or an acceptable equivalent from the information outlet to the termination point within the IDF or MDF/IDF room. The “J” hooks are to be installed a maximum of five feet apart and fastened to the ceiling or the top of the walls near the ceiling. The cables are to be tie-wrapped to the “J” hooks, without crimping the sheath. The cable contractor is to furnish and install the “J” hooks. Cooper B-Line BCM 21, 32, and 64 are acceptable.

5. Sleeves and Conduits

- a. The use of conduits and sleeves within a building is common for the transport of communications cable. Conduits and sleeves are to be sized and routes are to be planned within and between buildings in order to route the cable plant from the MDF to IDF and IDF to Information Outlet, and to accommodate any additional cabling required. The sizing of the conduits and sleeves is to be based on the number of cables, the location and environment surrounding the sleeve or conduit, and acceptable conduit fill levels, which are typically 40%. All conduits are to be installed with the appropriate sweep to maintain the required bend radius for copper and fiber optic cable. All sleeves and conduits are to be installed with bushings and suspended according to building industry standards.
- b. The following are guidelines to use in determining where sleeves and conduits are to be installed but does not limit nor identify all areas or situations where sleeves and conduits will be required.
 - All masonry walls that have cables passing through them are to have sleeves installed.
 - Gymnasiums and athletic areas are to have conduits installed to house cables passing through the area.
 - Each MDF and IDF Room is to have sleeves installed to contain the large number of cables exiting the room. Conduits are to be installed in areas where cables extend from one building to another via covered or enclosed bridges and corridors.
- c. Cable routing is to follow a “streets and avenues” path in corridors where possible. However, there are a number of reasons for exceptions. In some cases, the corridors do not allow cables to be run because of architectural constraints or inaccessible ceilings. Also, in order to maintain the 90-meter standard for Category 6 cabling, some cables need to be run separately and diagonally to isolated information outlets. Throughout all runs, the contractor is to maintain EIA/TIA standards regarding the proximity of communications cabling to high voltage cabling, motors, transformers, fluorescent lighting, ballasts, etc.

P. CABLING-GENERAL

1. All cable shall meet the requirements of the NEC, except where other authorities or codes impose a more stringent requirement or practice. Codes, such as the NEC, do not normally include transmission performance requirements. This section specifies the essential media transmission characteristics. It is advisable to consult standards associated with the planned service or equipment to determine any specific media limitations.
2. Contractor is to take all necessary precautions to assure that the maximum tensile load and minimum bend radius of all cables (fiber and copper) are not exceeded. When terminating Category 5e & 6 cable, care should be taken to maintain pair twists up to the termination point and not more than 0.5" of the cable pairs shall be untwisted. It is preferred that the cable sheath is also not removed more than 0.5" from the termination point. Tie wraps are to be hand-tightened on cables and are not to crimp the sheath. Contractor is responsible for protecting all connectorized cables from damage by other contractors at the information outlet before and after installation of the outlet faceplates.
3. All riser and station cable installed is to be plenum-rated cable. The fluoropolymer resin that insulates Category 6+ plenum cables is engineered as a fire safety innovation. The NEC requires that all cable installed in plenum spaces and not encased in conduit must have certain fire resistance and low smoke producing characteristics. Not only are such cables highly resistant to fire but they also produce very little smoke.

4. All new Voice cabling will be terminated onto Category 6 RJ45 Patch Panels. The fiber optic cabling will be terminated onto fiber distribution panels with LC connectors.
5. Cables shall be terminated on the appropriate unassigned (vacant) portions of the wall-mounted Main and Intermediate Distribution Frames or Patch Panels and run as uninterrupted conductor sections to the Information Outlets. All cable terminations shall be made uniformly in sequence, commencing with termination of the first cable pair on the first connection points in the upper left-hand corner of each block.
6. Minimum separation distances between pathways and power wiring of 480 V or less are shown in Table 1, below.

Table 1 Separation of Communications Pathways from <= 480V Power Lines

Condition	Minimum Separation Distances		
	< 2 kVA	2-5 kVA	> 5 kVA
Unshielded power lines or electrical equipment in proximity to open or nonmetal pathways.	127 mm (5 in)	305 mm (12 in)	610 mm (24 in)
Unshielded power lines or electrical equipment in proximity to a grounded metal conduit pathway	64 mm (2.5 in)	152 mm (6 in)	305 mm (12 in)
Power lines enclosed in a grounded metal conduit (or equivalent- shielding) in proximity to a grounded metal conduit pathway.	76 mm (3 in)	152 mm (6 in)	

All cabling shall be at least:

- 12" from high voltage lighting and fluorescent fixtures
- 72" from transformers and motors

Q. HORIZONTAL CABLING – CATEGORY 6 UTP DATA

All riser and station cable installed is to be plenum-rated cable.

1. Category 6 100 OHM balanced UTP Cable Requirements: In new construction projects, the default cabling infrastructure shall be Category 6 unless specified otherwise.
 - a. Cable construction shall be four twisted pairs of 23 AWG insulated solid conductors, with a ripcord, surrounded by a tight outer jacket.
 - b. All 4 pairs will have a cross-hair (X) physical separator between the pairs.
 - c. Conductor diameters shall be 0.0224" □ .0003" solid copper.
 - d. Conductor insulation diameter shall be 0.039" □ .0005" fluoro copolymer.
 - e. Outer jacket diameter shall be 0.235" □ .008" low smoke PVC, with a nominal wall thickness of 0.015".
 - f. Ripcord shall be directly underneath the outer jacket.
 - g. Cable shall be marked every 2 ft including
 - Cable Manufacturer
 - Cable Description
 - Month and Year of manufacture.
 - Job number.
 - h. UL, ETL, or CSA agency certification or verification markings shall be marked on the cable jacket according to the certifying agency's requirements.
 - i. Color coding of the pairs shall be as follows:

- Pair 1: White/Blue; Blue
 - Pair 2: White/Orange; Orange
 - Pair 3: White/Green; Green
 - Pair 4: White/Brown; Brown
- j. Cable shall be supplied in 1000 ft spools or 1000 ft Reelex boxes.
2. Category 6 100 OHM balanced UTP Cable Performance Requirements
- a. All transmission performance parameters shall be independently verified by a UL or ETL third party testing organization.
 - b. Cable shall exceed Category 6 transmission requirements specified in ANSI/TIA/EIA-568-B.2-1, and shall be tested through 550 MHz.
 - c. Worst-case cable performance shall be +8.0 dB headroom over current TIA/EIA and ISO standards limits for NEXT and PSNEXT loss, and ELFEXT and PSELFEXT loss.
 - d. Insertion loss shall be 3.0% lower than standard Hubbell Category 6+ plenum and riser cables described in Section 27 15 13.
 - e. Worst case electrical performance characteristics shall be as follows:
 - Characteristic Impedance: 100 + 15 (1.0-100 MHz) 100 + 20 (101-250 MHz)
 - Maximum Conductor Resistance: 9.38 /100 Meters @ 20°C
 - Maximum Resistance Unbalance: 3%
 - Maximum Mutual Capacitance: 5.6 nF/100 Meters @ 1 kHz
 - Maximum Capacitance Unbalance: 330 pF/100 Meters
 - Maximum Delay Skew: 25 ns/100 Meters
 - f. The manufacturer shall provide Category 6 component compliance certificates from third party testing organization upon request.
 - g. Cable shall be UL and C(UL) listed.
 - h. Cable shall exceed IEEE 802.3af DTE Power specification to 4 times the rated current limits with no degradation of performance or materials.
 - i. Cable shall be third party verified, error free Gigabit Ethernet performance to IEEE 802.3ab.
 - j. Cable shall exceed the requirements of TIA/TSB-155: 10 Gb/s Ethernet Operation over 55 Meters Channel Length.
 - k. Cable shall meet or exceed the 4-connector channel performance requirements of Category 6, per the ANSI/TIA/EIA-568-B.2-1 standard.
 - l. The 4-connector channel test configuration shall utilize Category 6 jacks and patch panels, with Category 6 patch cords, from the same manufacturer, with pre-qualified Category 6+ cable.
- 2a. Minimum Cable Performance:
- a. All measurements are at 250MHz
 - Insertions Loss: 32.7dB
 - NEXT: 41.4dB
 - ACR:8.6dB
 - ELFEXT: 23dB

- Return Loss: 17.5dB

3. Acceptable Manufacturers:

- a. Hubbell Premise Wiring: The Hubbell products listed in the table below comply with all requirements specified.

HUBBELL CATALOG NUMBER	Description
C6SPxx	NEXTSPEED Category 6 550 MHz – Plenum Spool
C6RPxx	NEXTSPEED Category 6 550 MHz – Plenum REELEX

xx = Cable color. Replace xx with “W” for White, “GY” for Gray, “B” for Blue, “Y” for Yellow. Refer to project drawing for color applications.

- b. Or approved equal of: Berk-Tek, Systemax, Panduit

4. Category 6 100 OHM balanced UTP Cable Installation Requirements

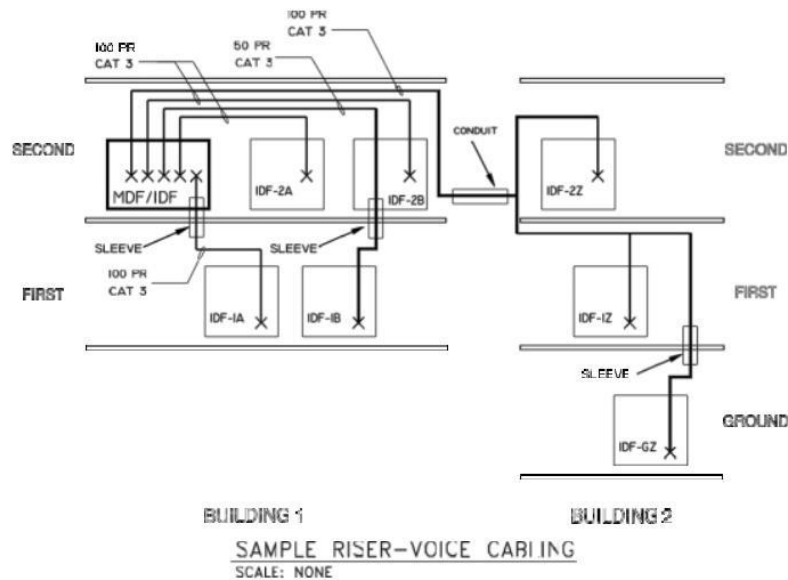
- Pull cable into conduits, or place into raceway or cable tray as specified. Do not exceed 25 Lb. pull force per cable. Use appropriate lubricants as required to reduce pulling friction.
- All exposed wiring shall be installed in surface raceway.
- All wiring above ceilings or below access floors shall be installed in cable tray or open-top cable hangers.
- Cable slack and service loops shall be stored properly above the ceiling or under the access floor. A “figure-eight” service loop is recommended for Category 6 cabling to reduce EMI coupling.
- Pathway fill ratio in conduit, tray, raceway, etc. shall not exceed 40% of pathway cross-sectional area.
- Installed cable bend radius shall be greater than 4X cable diameter. Avoid kinking or twisting the cable during installation.
- Do not over-tighten cable ties, and do not use staples or clamps to anchor cables. Velcro straps are recommended.
- Recommended spacing of cable supports above the ceiling shall be 48”.
- Maintain the following clearances from EMI sources:
 - Power cable: 6 in.
 - Florescent lights: 12 in.
 - Transformers and electrical service enclosures: 36 in.
- Communications cabling that must cross power cables or conduit shall cross at a 90-degree angle, and shall not make physical contact.
- Length of each horizontal cable run from the TR to the wall outlet shall not exceed 90 meters.
- Leave sufficient slack for 90 degree sweeps at all vertical drops.
- Do not install cable in wet areas, or in proximity to hot water pipes or boilers.
- Cable ends for termination shall be clean and free from crush marks, cuts, or kinks left from pulling operations.
- Installed cable jackets shall have no abrasions with exposed conductor insulation or bare copper ‘shiners’. The installer is responsible to replace damaged cables.

- p. Horizontal cables extending from mounted jacks or panels shall maintain a minimum bend radius of at least 4 times the cable diameter.
- q. Firestop all cable penetrations through fire-rated barriers per local codes.

R. VERITCAL DISTRIBUTION SYSTEMS

1. Riser Connectivity and Cable General

- a. The cabling system shall use a fiber/copper riser cable system between the IDF rooms and the MDF within the building.
- b. Fiber Riser shall be 12-strand single mode fiber optic cable is to be installed between each IDF and the MDF Room. These cables are to be terminated onto fiber optic patch panels located in the relay racks in each of the IDF rooms and the MDF Room. The 12-strand single mode fiber cable is to be connectorized with LC connectors on both ends.

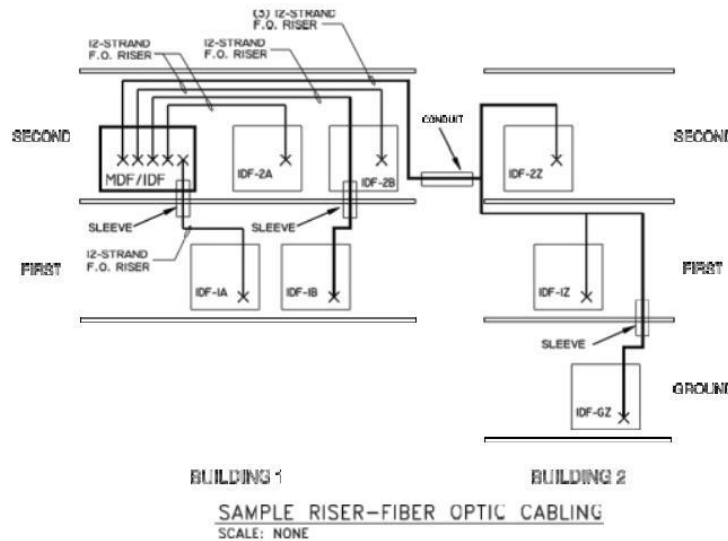


2. Fiber Backbone Distribution cable: indoor, armored

- a. Fiber Backbone Distribution cable Requirements
 - Optical Fiber Indoor Distribution Cable shall be constructed with 12 optical fibers, each coated with a 900 micron color-coded PVC tight buffer, surrounded by an aramid yarn strength member, Armored, and a single outer jacket with the appropriate flame rating.
 - Fiber cables shall be a non-metallic construction, OFNP (Plenum FT-6) flame rating.
 - Cable markings shall repeat every meter, and shall have at minimum the following information:
 - a. Sequential length indicator marking (meters)
 - b. Manufacturer's name and catalog number
 - c. Lot number, traceable back to the fiber draw lot
 - d. Date of Manufacture
 - e. Fiber type: (Singlemode)
 - f. Cable rating (OFNR, OFNP, etc.)

g. Applicable TeLCordia, TIA, IEC, and ICEA standard references and appropriate UL/CSA agency listings

- Cable jacket color shall be yellow for Singlemode 8.3/125 micron fiber.
- Buffer position color codes shall conform to standard ICEA and TIA-598 conventions as follows: 1-Blue, 2-Orange, 3-Green, 4-Brown, 5-Slate, 6-White, 7-Red, 9-Yellow, 10-Violet, 12-Aqua.
- Optical fiber in any cable construction shall be enhanced performance, bend-insensitive type.
- Singlemode cables shall perform at minimum to the attenuation, bandwidth, and distance application parameters in the table below.



Fiber Gigabit and 10 Gigabit Ethernet Application Chart					
Fiber Type	Wavelength (nm)	Max Attenuation (dB/km)	Bandwidth (MHz•Km)	1 GbE Distance (m) @ 850/1300nm	10 GbE Distance (m) @ 1300nm
SM 8.3 μm (OS2)	1310/1550	0.5/0.5	>25000	5000/-	10,000/40,000

- Optical fiber cables as supplied shall meet or exceed the applicable IEC 60793-1 qualification test requirements for optical, geometry, mechanical, and environmental parameters as specified, and tested in accordance with TIA/EIA-455.

b. PERFORMANCE REQUIREMENTS

- For installed fiber cables, all fiber strands shall pass insertion loss and return loss in accordance with test methods ANSI/TIA/EIA-526-14 for multimode cables.
- Installed fiber cables shall exceed all currently ratified bandwidth-distance-application performance parameters for IEEE 802.3ae (10 GbE) and for IEEE 802.3ba (40/100 GbE)
- Plenum cables shall be rated UL NFPA-262/UL910/CSA FT-6

c. Acceptable Manufacturers:

- Hubbell Premise Wiring or pre-approved equal. The Hubbell products listed in the table below comply with all requirements specified in this document

HUBBELL CATALOG NUMBER	Description
HFCD15012PS	Fiber Optic Cable – 12 Strand SM 8.3 μm (OS2), Plenum, Armored, yellow

- Or approved equal of: Panduit, Berk-Tek

d. Fiber Backbone Distribution cable: indoor, armored Installation Requirements

- Prior to cable deployment, backbone pathways (conduit, tray, raceway, wire basket, etc.) for cable routing shall be permanently installed in compliance with contract documents, and applicable codes and standards.
- Racks, cabinets or enclosures into which cables are to be routed shall be permanently installed in compliance with contract documents, and applicable codes and standards.
- Optical fiber cables shall be deployed using the proper pulling grip or apparatus attached to the exposed cable strength member. Contact the cable manufacturer regarding permissible methods for cable pulling. Never pull directly on the fiber strands of an optical fiber cable.
- Cables shall not exceed minimum bend radius limits or maximum pulling loads during or after installation. Avoid crushing or abrasion of the cable jacket during installation.
- Installed cables shall be fully supported and strain relieved from pulling on terminated connections. Apply wire ties loosely and avoid crushing or clamping cables with excessive force.
- All non-armored fiber optic riser cables are to be installed in plenum inner-duct. Fibers in innerduct or armored plenum riser serving as riser cables are to be installed according to the attached riser drawing. Contractor to size the inner-duct for each cable run. Multiple fiber optic cables can occupy an individual inner-duct when non-armored fiber is not used.

S. PATCH CABLES

1. Patch cables should meet the minimum performance requirements specified for each system. This requirement specifically prohibits the use of flat, non-twisted (also known as "silver satin") cords for Data or local area network applications. However, "silver satin" patch cables are acceptable for use in telephone systems.
2. The contractor shall provide two Category 6 Patch Cords for each end of each standard outlet for horizontal LAN connectivity. The cords are to be of varying lengths based on the patch panel, electronics equipment, and work area configurations. The quantity and lengths are to be documented and agreed upon, and the owner or Project Manager is to sign for them upon acceptance. These cords are to be stored in the MDF or IDF room for which they are designated.
3. The contractor is to provide LC to SC single-mode Patch Cords for connectivity for ports or equipment served by the fiber patch panel. The cords are to be of varying lengths based on the patch panel and electronics equipment configurations. These cords are to be stored in the MDF or IDF room for which they are designated.
4. Fiber Patch Cords
 - a. Fiber Patch Cord Requirements
 - Provide factory-made, LC to SC single-mode fiber cables in 1-Meter lengths for every fiber cable installed.

- LC Optical fiber patch cords shall be constructed with aramid-reinforced PVC loose-jacket duplex cable, with optical fibers having a 900-micron PVC buffer coating diameter. Optical fiber used in 10 GbE patch cords shall be laser optimized 50 or OS2 singlemode, per ANSI/TIA/EIA-492AAAC, with no substitutes.
- 50 micron core optical fiber within the patch cord cable shall be graded index type in accordance with ANSI/TIA/EIA-492AAAC, with the following specifications:
 - a. Core diameter: 50 +/-3.0 microns, or 8.3 micron for singelmode
 - b. Cladding diameter: 125 +/- 2.0 microns
 - c. Core/cladding concentricity: less than 3.0 microns
 - d. Core non-circularity: 6% maximum
 - e. Proof test: 100 kpsi
 - f. Effective modal bandwidth: 5700 MHz•km
 - g. Coating diameter: 245 +/-15 microns
 - h. Buffer diameter: 900 microns nominal
- Connector terminations on each end of the fiber patch cord shall be heat-cured epoxy type with a machine polish, inspected 100% for polish quality and mated-pair insertion loss.
- Epoxy volume within each connector shall be sufficient to properly surround and strain relieve the fiber and buffer layer at the buffer/fiber transition inside the connector body.
- Optical fiber patch cords shall be supplied in a sealed plastic bag with dust caps installed on each end, with insertion loss test results included.
- Optical fiber patch cords shall be available in standard lengths of 1, 2, 3, and 5 meters.
- Optical fiber patch cords shall be manufactured with industry standard LC or LC connector terminations on each end.
- Factory mounted connectors on each end of the patch cords shall comply with the applicable ANSI/TIA/EIA-604 Inter-mateability standard.
- Buffered fiber strands within the cable jacket shall be surrounded by aramid (Kevlar) material serving as a strength member.
- The aramid (Kevlar) strength member shall be mechanically secured at each connector to provide tensile strain relief of the optical fiber.
- Additional strain relief of the buffered fiber shall result from crimping the rear of the connector during termination.
- Duplex fiber patch cords shall be a zip-cord cable construction with jacket cross-section dimensions of 3.0 mm X 6.0 mm for LC style.
- Duplex fiber patch cords shall have reverse-pair polarity according to ANSI/TIA/EIA-568-B.3 and TIA/EIA-TSB-125.
- Cable jacket shall be marked with the cable manufacturer, UL Optical Fiber Non-Metallic Riser rating (Type OFNR) designation, lot number, and fiber core/cladding diameter designation.
- Fiber A-B polarity shall be clearly marked on each end of duplex patch cords.

- Optical fiber patch cord jacket color shall be aqua blue, specifically for 50 micron laser optimized singlemode fiber cables.
- Fiber patch cord connector materials shall be as follows:
 - a. LC Ferrules: zirconium ceramic
 - b. LC housings: injection molded thermoplastic
 - c. Dust Cap: nylon or PVC
 - d. Strain relief boot: UL94-V0 molded PVC
 - e. Strain relief boot on all connectors shall be beige.
 - f. LC connector outer housing shall be beige.
- b. Fiber Patch Cord Performance Requirements
 - 50 micron laser optimized and singlemode patch cords shall have a maximum mated-pair insertion loss of 0.60 dB per end, with a minimum return loss of -20 dB.
 - Fiber patch cords shall exceed 10 Gigabit Ethernet performance requirements of IEEE 802.3 standard.
 - Fiber patch cords shall exceed the mechanical reliability requirements for tensile, flex, twist and impact as specified in ANSI/TIA/EIA-568-B.3, Annex 'A'.
 - Fiber patch cords shall exceed the environmental reliability requirements for high/low temperature and humidity as specified in ANSI/TIA/EIA-568-B.3, Annex 'A'.
- c. Acceptable Manufacturers:
 - Hubbell Premise Wiring: The Hubbell products listed in the table below comply with all requirements specified in this document

HUBBELL CATALOG NUMBER	Description
DFPCLCSCSySM (yy=length-1,2,3,5m)	LC-SC Optical Fiber Patch cords, OS2-SM, yellow

- Or approved equal of: Ortronics, Panduit, Systimax.
5. Category 6 Patch Cords: In new construction projects, the default cabling infrastructure shall be Category 6 unless specified otherwise.
- a. Category 6 Patch Cord Requirements
 - The contractor shall provide two Category 6 Patch Cords for each end of each standard outlet for horizontal LAN connectivity. The cords are to be of varying lengths based on the patch panel, electronics equipment, and work area configurations. The quantity and lengths are to be documented and agreed upon, and the owner or Project Manager is to sign for them upon acceptance. These cords are to be stored in the MDF or IDF room for which they are designated.
 - Category 6 patch cords shall be constructed with a clear polycarbonate plug and boot having vertically staggered, trifurcated contacts, each having 50 micro-inches of gold plating.
 - Plug dimensions and function shall comply with FCC 47, Part 68.5.
 - Patch cords shall have a snag-less feature, integral to the strain relief boot on each end.

- Patch cords shall be constructed with category 6 patch cable, with 24 AWG 7/32 tinned copper stranded conductors, each insulated with polyethylene, and overall jacket with UL flame-retardant PVC.
- Patch cords shall be manufactured using a T568B wiring format, and shall function suitably for either T568A or T568B wiring schemes.
- Patch cords shall be available in the following colors: black, blue, gray, yellow, orange, red, green, white, and purple. Custom lengths and colors shall be available with a delivery lead- time quotation.
- Standard patch cord lengths shall range from 1 ft. to 20 ft. □
- Category 6 patch cords shall be backward compatible with existing Category 5 and 5e cabling systems for fit, form, and function.

b. Category 6 Patch Cords

- All transmission performance parameters shall be independently verified by a UL or ETL third party testing organization.
- Category 6 patch cords shall be channel performance balanced with Hubbell category 6 jacks, patch panels, and punch-down blocks.
- Category 6 patch cords shall meet or exceed Category 6 component transmission requirements for connecting hardware, as specified in ANSI/TIA/EIA-568-B.2-1 standard.
- The manufacturer shall provide Category 6 component compliance certificates from third party testing organization upon request.
- Patch cords shall be cUL and UL LISTED 1863.
- Patch cords shall exceed IEEE 802.3 DTE Power specification to 4 times the rated current limits with no degradation of performance or materials.
- Patch cords shall be third party verified, error-free Gigabit Ethernet performance to IEEE 802.3 standard.
- Jacks shall exceed 4 Gb/s data transmission capacity within the bandwidth of 1 – 250 MHz when configured in a 4-connector channel.
- Category 6 patch cords shall meet or exceed the 4-connector channel transmission performance requirements of Category 6, per ANSI/TIA/EIA-568-C.2 standard.
- The 4-connector channel test configuration shall utilize Category 6 patch panels, blocks, and jacks.

c. Acceptable Manufacturers:

- Hubbell Premise Wiring: The Hubbell products listed in the table below comply with all requirements specified in this document

HUBBELL CATALOG NUMBER	Description
HC6xx01	Category 6 Patch Cord, 1FT
HC6xx03	Category 6 Patch Cord, 3FT
HC6xx05	Category 6 Patch Cord, 5FT
HC6xx07	Category 6 Patch Cord, 7FT
HC6xx010	Category 6 Patch Cord, 10FT
HC6xx15	Category 6 Patch Cord, 15FT
HC6xx20	Category 6 Patch Cord, 20FT
HC6xx25	Category 6 Patch Cord, 25FT

xx = Cable Color. Replace xx with “W” for White, “BK” for Black, “B” for Blue, “GY” for Gray, “GN” for Green, “P” for Purple, “OR” for Orange, “R” for Red, “Y” for Yellow. Refer to project drawing for color applications.

- Or approved equal of: Ortronics, Panduit, Systimax.

T. FIRE STOP – PENETRATION SEALANT

1. Provide fire-resistant silicone foam fill to restore fire ratings to all wall, floor, or ceiling penetrations. Foam must be UL classified and meet NEC and local code.
2. All penetrations through fire-rated floors and walls shall be sealed to prevent the passage of smoke, fire, toxic gas, or water. The fire rating of the penetration seal shall be at least that of the floor or wall into which it is installed, so that the original fire rating of the floor or wall is maintained as required by Article 300-21 of the National Electric Code.
3. No flammable material may be used to line the chase of the hole in which the fire stop material is to be installed.
4. When damming materials are to be left in place after the seal is complete, then all such materials shall be non-flammable.
5. The sealant shall be poured into the hole after each cable has been spread to allow a minimum of ½" of foam to flow between them. No cables may be touching each other, because contact between cables could allow voids to form in the fire stop.
6. If plastic cartridges are used for smaller installations, the chemical components of the foam shall be pre-measured within the cartridges to ensure the proper ratios.
7. The sealant shall remain resilient and pliable to allow for the removal and/or addition of cable without the necessity of drilling holes. It shall adhere to itself perfectly to allow any and all repairs to be made with the same material. It shall allow for vibration, expansion, and/or contraction of anything passing through the penetration without affecting the seal, or cracking, crumbling, and spalling.
8. When sealant is injected into a penetration, the foam shall expand to surround all the items within the penetration at that time and be fire resistant, maintaining the pass-minute rating. No heat shall be required to further expand the foam to block the passage of fire and smoke or water.
9. The foam sealant material shall have been subjected to fire exposure testing in accordance with standard time-temperature curve in the Standard, UL, ASTM E
10. 119, and NJPA 251. The foam fire-stop material shall also have been subjected to the hose stream test in accordance with UL 10B.

U. TESTING

1. General Test Procedures
 - a. Before an application for final acceptance of the work will be considered, all tests stated within this section shall be satisfactorily completed. The communications work shall include miscellaneous tasks, (e.g., removal of panel trims, junction, and pull box covers) deemed necessary to demonstrate compliance with the requirements of the Communications specifications, as well as cable and equipment manufacturers' recommended installation procedures.
 - b. Upon completion of testing and problem resolution, all connections must be 100% error free: "Error free" is defined to mean the item meets all the manufacturers' specifications and recommendations as published in their latest manufacturing manuals for proper installation and testing. In addition, each item must conform with all other related industrial practices and standards, Building Trades, and Electrical and Communications

Industry Standards and Practices.

- c. Upon successful completion of each item of testing, the Contractor shall issue in writing a certificate of compliance, along with the test results, to the Project Manager. All failed CAT-6 cables and/or Fiber strands shall be clearly labeled and identified as defective, with the type of defect (i.e. open ring side, grounded tip, short, excessive loss, etc.) identified.
 - d. The Contractor will attempt to remedy any defective copper cable pair or Fiber cable strand and specify in the documentation the location of the problem as identified during the testing procedures. The Fiber trouble location and identification must be completed with an OTDR.
2. Copper Cable Test Procedures
- a. Contractor must complete cable system performance verifications on all copper and fiber cable as specified below and provide the test results to the owner or project manager. Category 6 – 6a cable must meet or exceed all manufacturer's and EIA/TIA standards for performance and installation. Fiber cable must also meet or exceed all manufacturer's and EIA/TIA standards for performance and installation.
 - b. All copper and fiber optic testing documentation is to be submitted on a CD, as well as 8.5" x 11" hard copies.
 - c. At a minimum, in addition to any other required testing, the Contractor shall conduct and report on the following tests of copper cabling after the installation is complete:
 - MDF-to-IDF tests of all new riser pairs installed under this contract, to determine continuity, shorts, crossed pairs, correct pinning, and grounds.
 - IDF (patch panels)–to-information outlet tests of all new cable pairs installed under this contract, to determine continuity, shorts, crossed pairs, correct pinning, and grounds.
 - The coaxial cable is to be tested from the MDF Room to the IDF Room and from the IDF Room to the coax outlet. Contractor is to test for continuity, shorts, and grounds.
 - The horizontal Category 6 cabling, installed from the IDF Room to the Information Outlet at the workstation, is to be manufacturer certified and warranted for Category 6 compliance. All manufacturers' performance certificates and extended warranties are to be provided to the owner or project manager upon completion of the testing and manufacturer certification. Contractor is to present copies of certificates identifying the contractor as a current certified VAR for the selected cabling system and therefore, qualified to install a certified cable plant.
 - All Category 6 cabling is to be tested end-to-end and documented for Category 6 compliance at all frequencies up to and including 250MHz for 6. Such testing is to comply with the procedures and standards outlined by the cable manufacturer and EIA/TIA TSB - 67 concerning testing of Category 6 cable plant.
 - A certified Cat 6 testing system is to be used for such testing to insure that cable pairs are defect free. "Defect free" for the copper cable is defined as a copper pair not having any pair reversals, split pairs, shorts or opens. Test results shall be provided to the Owner or Project Manager within 2 days after testing or 5 days prior to the Owner connecting electronic equipment onto the cable network, whichever is sooner. The contractor must also provide testing summary reports of all category 6 cables including run numbers, and pass/fail results with respect to length, impedance, DC resistance, mutual capacitance, attenuation, NEXT loss, and active ACR. The contractor must also provide spreadsheet analysis of the linearly dependent

parameters of length, DC resistance, mutual capacitance, and attenuation; the field measured values shall be compared to the specification's values on one spreadsheet.

- In the event that a CAT 6 cable fails to perform to the manufacturer's specifications, the Contractor will, at the owner's request, remove the cable and replace it with a new cable, replacing the defective cable at no additional expense to the owner.
- End-to-end testing is required for every RJ-45 connection. An owner's representative may accompany the Contractor's staff to witness the end-to-end testing. End-to-end testing is defined herein as testing all cabling links to the very last termination point. The Contractor is required to supply sufficient quantities of two-way radios and test equipment to ensure that the tests are completed accurately and expeditiously.
- The Owner, DTI, or Project manager may conduct performance tests of transport electronics connected to the cabling system. Successful equipment performance tests do not relieve the Contractor from the specified testing, repair, and documentation requirements.
- The Contractor shall provide to the Owner or Project Manager with copies of all copper-cable test results.

3. Fiber Optic Cable Test Procedures

- a. All fiber optic cable and associated equipment lateral, and vertical riser cabling must be thoroughly tested. The fiber cable will be accepted only after each strand is tested in accordance with the specifications defined herein. All strands are to be tested and found to be 100% acceptable.
- b. The Contractor shall test all cables, connectors, associated equipment, and hardware furnished by the Contractor upon receipt of same as defined herein.
- c. As a minimum, the Contractor shall test, as described below, all optical fiber cable strands installed within the scope of this proposal:
 - Fully test complete links only. Piecemeal testing is not acceptable.
 - Perform end-to-end, bi-directional attenuation (loss) test for each fiber strand at 1310 and 1550 for singelmode. Conduct tests in accordance with EIA/TIA-526-14, Method B and with test instrument manufacturer's published instructions.
 - a. Demonstrate that measured link loss does not exceed the expected value based on the number of mated connector pairs, the connector's published loss per mated pair, and the cable's published loss based on distance.
 - b. Strands whose measured attenuation falls outside the acceptable range shall be subject to further inspection and testing to determine the nature of the fault. At a minimum, an OTDR shall be used to: determine the true loss for each connector pair and the exact length of the fiber, and to identify the presence of any core damage.
 - c. Riser end-to-end testing of individual optical fibers is considered to be from the MDF Room to the IDF Rooms distribution panels on each floor.
- Faults related to connectors shall be corrected and the fiber re-tested as stated above until acceptable attenuation measurements are received.
- Where defects are found to be inherent in the fiber itself, notify the Project Manager in writing. Upon obtaining approval by the Project Manager, replace any cable having fewer than the manufacturer's guaranteed number of serviceable fibers.
- Remove all newly installed defective cables from pathways. Do not abandon cables in place.

- All test results and corrective procedures are to be documented and submitted as a spreadsheet, and digitally on a USB thumb drive to State/DTI within five (5) working days of test completion.
- Considering that the fiber cable plant is to be certified, each test report form shall provide at least the following information:
 - a. Project name
 - b. Contractor's name
 - c. Date(s) of preparation and of testing
 - d. Fiber type, strand count, connectors and patches
 - e. Designated cable number (regardless of whether only one cable of each type is present) and individual fiber numbers
 - f. Make, model, serial number, and date of last calibration of test equipment used
 - g. Name of test crew foreman
 - h. Test results: Calculated maximum link loss, length of run, OTDR, and also
 - i. Power Meter-measured link loss for each fiber, pass/fail result, and comments.
- In addition to the tests specified above, the Contractor shall be present while the Owner or Project Manager conducts performance tests of the transport electronics connected to the cabling system; the contractor shall conduct on- the-spot cable tests and effect cable plant repairs as necessary. Successful equipment performance tests do not relieve the Contractor from the specified testing, repair, and documentation requirements.
- Recommended test equipment:
 - a. Optical fiber power meter and Light Source: OS-100D Light Source, or equivalent.
 - b. TDR: Tektronix TFP2 FiberMaster, Laser Precision TD-2000 or equivalent with 850nm and 1300nm emitter modules and hard copy printout, or equivalent.
 - c. Optical fiber inspection scope: Cambridge Instruments 10x fiber scope, or equivalent.
- The Contractor shall provide copies of all fiber and copper cable test results to the Owner or Project Manager.
- All fiber optic cabling (workstation and riser) is to be installed in a manner that complies with and allows Owner to receive the manufacturer's extended warranty. The contractor is to be certified and authorized to provide the extended warranty. A manufacturer's extended warranty is to be provided, through the contractor, upon completion of the testing and manufacturer's certification. Contractor is to present copies of certificates identifying the contractor as a current certified VAR and therefore, qualified to certify and install the cable plant.
- The Owner and Project Manager reserves the right to observe any or all portions of the testing. Notification of testing is at least three days prior to start of testing.

4. Replacement

- a. Any fiber strand, connector, block, or module installed by the Contractor that fails to meet the loss budget, or that tests below the manufacturer's standards, shall be replaced at no additional cost to the owners or State/DTI. The replacement cable, connector, or part shall be tested after repairs have been made to verify compliance. Only equipment that

meets the installation requirements stated herein shall meet the system's acceptance requirements.

5. Source Manufacturing/Quality Control
 - a. Cables that are supplied by the Contractor, and test outside of the factory test data by a margin of 10 percent on loss, may be deemed non-usable and returned to the manufacturer for replacement.
6. Physical Inspection: Prior to conducting any transmission testing, the following visual inspections will be performed:
 - a. Verify that all cable has been installed in full compliance with the proposal specifications.
 - b. Check for physical damage to the Fiber Distribution Panels and termination hardware.
 - c. Check that all cabling is properly jacketed, installation properly labeled at both ends of the cable, inner-duct and termination hardware is completed in all IDFs and the MDF Room.
 - d. Verify that all cable bends are within the manufacturer's specified bend radius.
 - e. Verify that all cabinets and racks (which require grounding) are properly grounded and comply with the National and Local Electrical Codes and State Standards for grounding.
 - f. Verify that the cables are properly approved and structurally supported for termination.
 - g. Verify that all Delaware Fire Code requirements have been met and satisfied.
7. DOCUMENTATION
 - a. Proper labeling and documentation will allow a technician to quickly trace a particular cable link and will significantly reduce the time and costs of moves, additions, changes, and troubleshooting. Both labeling and documentation depend on the use of a system-wide coding LCheme that will identify and locate each component of the wiring system and allow all components to be linked in a logical fashion.
 - b. There are three components of wiring system documentation:
 - (1) Labeling Communications/Data room/closet termination areas aids in identifying the source and function of a circuit.
 - (2) A labeling scheme simplifies the documentation process.
 - (3) "As built" documents provide a permanent record of the communications infrastructure. These documents are a critical management resource. As a result, it is imperative that "as built" documentation be prepared as part of the communications infrastructure project. In addition, these documents must be kept current throughout the system's life cycle.
8. Termination Blocks
 - a. Labels on the connecting hardware should be coded based on the function of the terminated wiring. Colored designation strips are typically provided with a termination block.
9. Cable and Information Outlet Identification: The Contractor shall furnish and install cable tags labeled with identifying cable numbers mutually agreed upon with contractor and the Owner or Project Manager.
 - a. The Contractor shall clearly and consistently mark the appropriate designation strip labels on all termination hardware mutually agreed upon with the Owner or Project Manager. Contractor will submit a sample of all designation labels for approval before installation.

- b. The Contractor shall affix outlet identification labels, machine printed or typed, with identifying cable numbers as shown on the attached drawings.
 - c. Subsequent to pulling and terminating cables, the Contractor shall place the appropriate cable tags within six (6) inches of each end of each copper cable and eighteen (18) inches of each optical fiber cable end.
 - d. If the cable tape becomes illegible or is removed at any time during the job, the
 - e. Contractor shall immediately replace it with a duplicate preprinted cable tag.
 - f. The Contractor shall provide the Owner or Project Manager with a listing of all cable identification numbers, keyed to cable types.
 - g. Contractor will label each information outlet with the following labeling scheme: If the 1st floor IDF closet "A" is the origination point of the cable feeding workstation "007" the following is the configuration of the label to be installed:
 - Floor- IDF Closet - Information Outlet Number
 - Example: 1A-007
 - h. Contractor will submit for approval a sample of all information outlet designation labels.
10. "As-Built" Documentation
- a. Maintaining records and documents is the most important portion of the administration of a communications infrastructure. Maintenance and moves, additions, and changes can become very difficult if a current set of records and documents is not maintained. In fact, isolation and resolution of problems are often delayed because configuration information is either unavailable or outdated.
 - b. Subsequent to the installation and prior to acceptance, the Contractor shall prepare and issue As-Built drawings, in an AutoCAD format, that shall reflect the lengths of cables installed and the actual manner and conditions of installation, including all deletions from, additions to, or departures from the contract documents. These documents are to include the information outlet station numbers and cable routing where they vary from the original plan. A copy of these documents will be stored in the MDF, with a master copy located at the Owner or Project Manager.
11. Cable Management System
- a. Wiring and equipment relationships must be maintained in a database or spreadsheet (depending on their complexity). The best approach is to use a third- party vendor's application for tracking cable management. These records contain comprehensive information about the users' communications configuration. The information will be very valuable in the support of long-term user-community communications requirements.

V. APPENDIX A – COMMUNICATIONS PLANNING CHECKLIST

- 1. Space allocation for Communications/Data Room/Closets
 - a. Based on a number of factors, including the:
 - Type of equipment to be installed
 - Size of the phone and data termination backboards
 - Access to floor cores and conduits
 - Cable tray requirements
 - Location, size, and swing of the Communications/Data room/closet door(s)
 - b. Square footage is not as important as the actual floor dimensions and the placement of the equipment. It is possible to design around some obstacles and still have a functional

facility. For instance, an oblong room is not as desirable as a square room having the same square footage.

- c. The criteria for establishing the size of a Communications/Data room/closet and determining whether or not it is functionally acceptable are complex. Answering the following questions is the first step in determining the long-term feasibility of a communications room or closet:
 - What will be the closet's primary function: phone, data, or combined services?
 - Where is it located in proximity to serviced workstations, network rooms, and other Communications/Data rooms/closets?
 - What type of equipment is going to be in the room/closet?
 - Is it wall- and/or rack-mounted?
 - How much equipment will be put in the room/closet? What are the dimensions of those devices?
 - What are their environment requirements?
 - Based on the type(s) of equipment going into the room/closet, what is the installation, maintenance, and operator work space required around the equipment?
 - Can the equipment be attached securely to the structure?
 - What cable types are being used? What are the cable separation requirements? Where are the cables terminated within the closet?
 - Does equipment mounted in the closet require an open space? Is there any other device needing clear space?
 - Is the room/closet securable? Do other entities need access to the space? What are their space requirements?
 - What size is the door? Does it swing in or out? Can the door be modified?
 - Is power available? Can it support the room/closet electrical requirements? Can it be modified?
 - Does the room need air conditioning? Does it ventilate well? Can it be modified?
 - Where are the floor cores and the ceiling access points for conduits?
 - Are there expansion requirements? Can the expansion requirements be accommodated by the room/closet size? Can the closet be enlarged at a later date?

W. APPENDIX B – CABLE INSTALLATION CHECKLIST

1. Check Local Building Codes

The requirements stipulated by Section 800 of the National Electrical Code for Communications cable installations produce an orderly installation. However, it is important to consult your building inspector to determine whether there are special local requirements. Strapping requirements depend upon the building's design, State and Local Standards, and codes. Terminations can be made in standard junction boxes.

2. Coordinate with Other Contractors

Plan to install the cabling system in new buildings after the power wiring, air- handling ducts, and ceiling supports have been installed, but before the ceiling tiles are in place. This will prevent damage to the cable system during construction.

3. Plan the Job

On a blueprint, mark all terminations and desired routings, if known, to accommodate future building modifications.

4. Label the Cables

Label each cable reel and its free end according to the termination locations marked on your blueprint.

5. Pull Cable into Place

Deliver the cable from the bottom of each reel, making sure not to kink, crush, or pinch the cable. Pull groups of cables to a logical point and then fan out to the individual termination points. Arrange the cables neatly so they are easily identifiable for relocation. Separate the Communications cables from other cables by at least six inches and avoid sharp edges, tight bends, and locations that would subject the cable to abrasion, corrosion, or moisture. According to the National Electrical Code, low-voltage cables cannot share a tray with power cables. Running signal cables close to power cables may also cause hum pickup. If in doubt about cable locations, consult the standards or the Owner.

6. Remove Slack

Remove slack in lines by pulling the cables back to the wiring room and by adjusting their ceiling location as needed.

7. Label and Cut

Label each cable and then cut it off, making sure to leave enough cable to reach the termination panel.

8. Tie Cables Together

Use cable ties to bundle and secure parallel runs together. Place the ties at intervals sufficient to prevent sagging and to maintain neatness. Distances between ties may vary from six inches to four feet, depending on the size of the cables.

9. Strap the Cable

Use straps to fasten the tied cable bundles to hangers at 4-foot or other appropriate intervals. The distance between hangers will vary from 3 to 20 feet, depending upon the strapping surface, the type and number of cables in each bundle, State and Local Standards, and codes. Make sure to support the cables with hangers rather than pipes, conduit, or other structures in the building plenum. If space permits, use existing hangers; otherwise, install new ones. Do not use straps that are too small for the cable diameter because they can cut or pinch the cable insulation.

10. Inspect the Job

Be sure that the cables are not resting on false ceilings or near electrical fixtures or sagging more than three inches from the point of the tie wrap.

X. APPENDIX C – QUALTY ASSURANCE

1. All materials used shall bear the Underwriters' Laboratory, Inc. label, provided a standard has been established for the material in question.
2. All products and materials shall be new and unused, clean, and free of defects, damage, and corrosion.

Y. APPENDIX D – CODES, REGULATIONS, AND STANDARDS

1. All installations and equipment shall be in compliance with, equal to or exceed the minimum requirements of OSHA, NEC, NEMA, IEEE, SAME, ANSI, UL, EIA, TIA recommendations and the rules, regulations and requirements of the Federal Communications Commission.

2. The installation shall comply fully with all applicable Local, County and State of
3. Delaware laws and ordinances, regulations, and codes.
4. Local electrical and building codes in Delaware may be more restrictive than national codes, recommendations or practice. Follow the most restrictive code or recommendations.
5. Should any change in plans or Specifications be required to comply with governmental regulations, the Contractor shall notify the Owner or Project Manager at the time of submitting the construction schedule.

Z. APPENDIX E – WARRANTY

1. Besides the manufacturer's extended warranty the Contractor shall submit a single Guarantee stating that all portions of the work are in accordance with Contract requirements and guaranteeing all work against faulty and improper material and workmanship, including work and materials of all subcontractors, manufacturers, suppliers, and sub trade specialists, for a period of twenty-five (25) years from date of final acceptance by the project manager, State/DTI, and Owner. Where guarantees or warranties for longer terms are provided, such longer terms shall apply. Within 24 hours after notification, the Contractor shall correct any deficiencies that occur during the guarantee period at no additional cost to Owner, all to the satisfaction of the Project Manager and or Owner.
2. When installed by a Certified Installer and used in a Structured Cable System, the manufacturer's extended warranty shall cover the installation for a period of 25 years against defects in material and workmanship. It shall also guarantee that it will support any current and future applications designed for Data transmission over the 100/500MHz link/channel, as defined in TIA/EIA 568A Communications Standard.
3. All move, add and change (MAC) activity shall be covered by the warranty provided it is performed by a Certified Installer.

AA. APPENDIX F – BID/QUOTE RESPONSE FORMAT

1. Proposal identification number or control number. This number will be used as a reference for this individual proposal and will facilitate coordinating multiple bids or quotes for the same location or job site.
2. Requesting State Agency and Contact name, phone number and address. This should be the name of the State agency requesting the quote or bid and that agency's contact person's phone number(s) and address.
3. Building or office location address. This address should be the actual location of the job site. This address should include the floor numbers, if more than one story, and building numbers or names, if more than one building is involved.
4. Total Cost of Bid/Proposal. This dollar amount should include the total material and labor cost. The material and labor cost should be stated separately and then totaled. Also state whether or not labor costs are based on prevailing wage standards or not.

Example:

Material	\$3,500.00
Labor Prevailing	\$2,750.00
Total	\$6,250.00

5. Scope of Work. This section should be a written description of the work to be performed. It should be function-specific.

Example:

- Install, terminate both ends, test, and label XX work area locations consisting of one Voice and two Data CAT6 cables and CAT6 568-B RJ45 jacks.
- Install one Voice cable from the Communications Closet to the Fir/Security Alarm Panel location.
- Provide and install a 100-pair plenum-rated riser cable from the boiler room to the main communications closet and terminate on 110 type wall mount hardware.
- Provide and install 7' relay racks and CAT6 patch panels.

6. Material

The material should be and itemized list with manufacturer's name and part numbers, including all piece parts and quantity of each. Total man hours to complete the job should be included as an item in the list.

Hubbell Cable	Blue	C6RPB	2,800 ft
Hubbell Cable	White	C6RPW	2,000 ft
Hubbell Jack Single		HXJ6xx	14 ea
Hubbell Jack Double		HXJ6xx	14 ea
Hubbell 110 block		30200007	1 ea
Hubbell Panel P6E48U		951044344	1 ea
~~CIRCA protector panel~~		~~1880ECAS1-100G~~	~~2 ea~~
~~1 pair fuse CIRCA~~		~~4B1E~~	~~200 ea~~
etc.			
etc.			
etc.			
Labor Man Hours			75 hr

7. Warranty

This should include the name of the manufacturer from which the State will receive the warranty and the type and length of the warranty or warranties provided with the cabling solution that is proposed. 25 years is required.

BB. APPENDIX H – CERTIFIED CONTRACTOR LIST

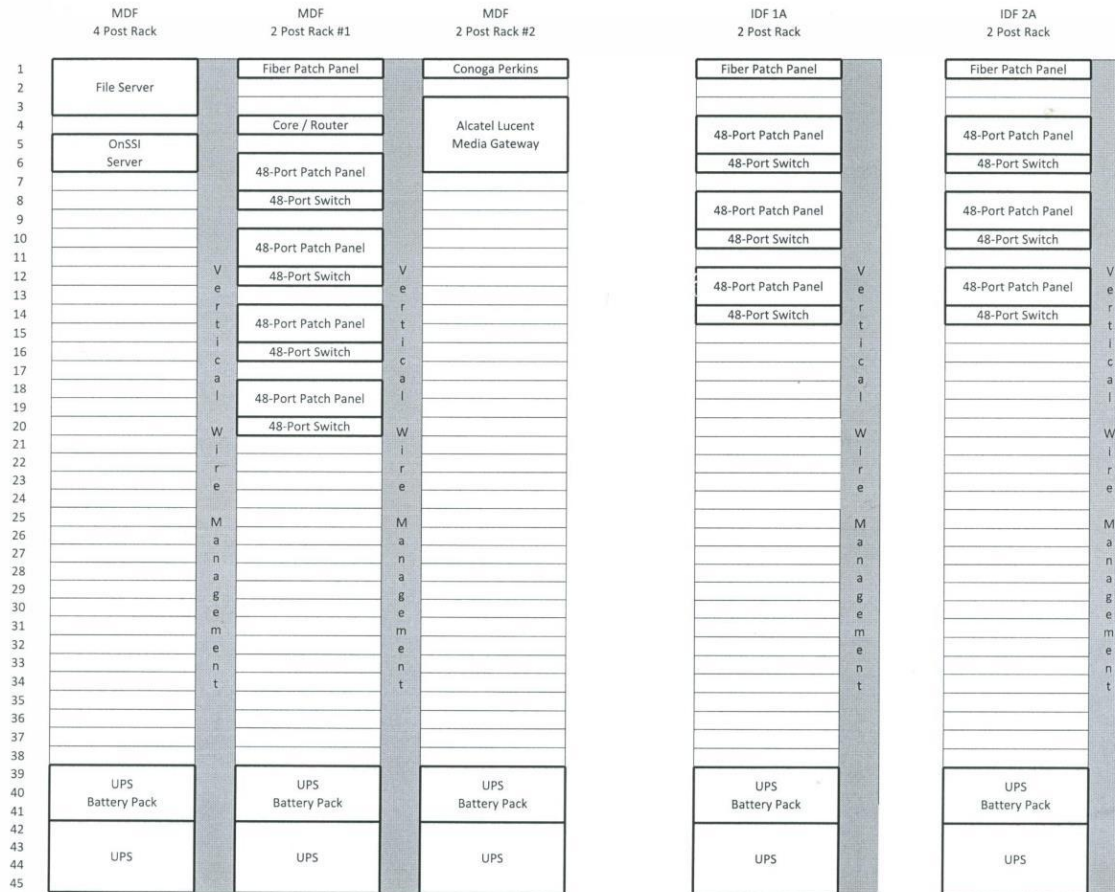
GSS16441-DATA_CBLV01 Advantech Incorporated 151 Garrison Oak Drive Dover, DE 19901 David Sweeney Phone: 302-674-8405 ext 123 Fax: 302-674-3698 Cell: 302-359-0189 Daves@advantechsecurity.net FSF ID#: 0000027017	GSS16441-DATA_CBLV02 Arugie Enterprises Corp. dba: ARG Communications 612 S Colonial Ave, Ste. A Wilmington, DE 19805 Joseph Ruggieri Phone: 302-225-2000 ext 301 Fax: 302-225-2010 Cell: 302-584-0010 joe@whyarg.com FSF ID#: 0000000456	GSS16441-DATA_CBLV03 Assurance Medica, LLC 590 Centruy Blvd., Suite B Wilmington, DE 19808 Chris Honeycutt Phone: 302-993-4486 Fax: 866-246-1153 Cell: 302-363-1500 choneycutt@assurancemedia.net FSF ID#: 0000020739

	GSS16441-DATA_CBLV05 KCI Communications Infrastructure 921 Mercantile Drive, Suite H Hannover, MD 21706 Josh Wilkerson Phone: 410-309-7902 ext 8614 josh.wilkerson@kci.com FSF ID#: 0000271910	GSS16441-DATA_CBLV06 Skyline Technology Solutions, LLC 6956-F Aviation Boulevard Glen Burnie, MD 21061 Jason Ross Phone: 410-590-2002 Fax: 410-787-2551 Cell: 443-398-7917 jross@skylinenet.net FSF ID#: 0000313842
GSS16441-DATA_CBLV07 Tangent Cable Systems, Inc. 3700 Washington Avenue Wilmington, DE 19808 Chad Myers Phone: 302-994-4104 Fax: 302-994-4105 Cell: 302-463-2396 cmyers@tangentcable.com FSF ID#: 0000027967	GSS16441-DATA_CBLV08 Troy Ventures, LLC dba: ThinkSecureNet, LLC and SecureNetMD, LLC 16557 Coastal Highway Lewes, DE 19958 Andrew Laroche Phone: 302-645-7770 ext 800 Cell: 860-305-4787 drew@securenetmd.com FSF ID#: 0000317474, 0000261617, 0000453212	GSS16441-DATA_CBLV09 Under.Comm, Inc. 198 Mullet Run Milford, DE 19963 Scott Hermansader Phone: 302-424-1554 Fax: 302-424-4478 Cell: 302-222-236 scott@undercomm.com FSF ID#: 0000030544

Awarded Categories:

Vendor	General Structured Cabling	DTI Dark Finer
Advantech Incorporated	X	
ARG Communications	X	
Assurance Media	X	X
KCI Communications	X	
Skyline Technology Solutions	X	
Tangent Cable Systems	X	
Troy Ventures	X	
Under/Comm	X	

2.2 DISTRICT STANDARD RACK LAYOUTS



END OF SECTION

SECTION 26 07 71**INTERCOM/TELECOMMUNICATION AND CLOCK SYSTEM****PART 1 – GENERAL****1.1 General**

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specifications Sections, apply to work of this section. Electrical Contractor shall provide device boxes, conduit stubs, and pull strings for all wall-mounted speakers.
- B. This section is a Division 26 Communications System, and is part of each Division-26 Section making reference to the telecommunications system specified herein.
- C. The contractor shall furnish and install all equipment including, but not limited to, outlet boxes, conduit (with pull strings), wiring, cable, speakers, telephones and clocks as shown on the plans, and all other equipment necessary to provide a complete and operating system for the Appoquinimink School District-

1.2 Scope of Work

- A. Provide a telephone type communications system for all instructional and administrative areas. Provide for system integration of the following basic school communications systems including the Cafetorium and local classroom sound systems.
 - 1. Telephone System
 - 2. Voice Mail System
 - 3. Intercom/Public Address System
- B. Volp Telephone System: System provides for the interconnection to public telephone lines and intercommunications throughout the school. Each classroom or office provided with a telephone can communicate with any other internal telephone by touch-tone access. Integrate with the public telephone lines to provide inward and outward telephone calls on a controlled basis. Features and functions of the telephone system includes:
 - 1. Private two-way telephone handset to handset communications.
 - 2. Direct dial communications.
 - 3. Dial access to intercom system for public address.
 - 4. Administrative control console with display and busy lamp field.
 - 5. Multi-line telephones.
 - 6. Software programmable features, functions, and restrictions.
- C. Voice Mail System: Provide system that utilizes recorded voice messages that are accessible from any touch tone telephone. System shall be fully integrated to digital telephone system. System shall provide the following features and functions.
 - 1. Ability to light and extinguish message lights automatically.
 - 2. Automated Attendant
 - 3. Voice Mail
- D. Intercom/Public Address System: Provide speaker and amplifier system for paging and public address throughout the school. Provide program channels for cassette tape players and AM/FM radio. System provides the following features and functions.
 - 1. Audio program to classrooms.
 - 2. Emergency paging.

3. All call paging.
 4. Zone paging.
 5. Hands-free intercom speaker communication.
 6. Distribution of master clock class change tones.
- 1.3 Reference Standards
- A. National Fire Protection Association:
 1. NFPA 70-90: National Electrical Code.
 - B. Underwriters Laboratories, Inc.:
 1. UL 486A-91: Wire connectors and soldering lugs for use with copper conductors.
 2. UL 1449-85: Transient voltage surge suppressors.
 3. Comply with UL 1863.
 - C. Electronics Industries Association:
 1. EIA 568-91: Commercial Building Telecommunications Wiring Standard.
 2. EIA-160: Sound Systems.
 3. EIA-299A: Loudspeakers, Dynamic Magnetic Structures and Impedance.
 4. EIA-310A: Racks, Panels and Associated Equipment.
 5. SE-101-A: Amplifier for Sound Equipment.
 6. SE-103: Speakers for Sound Equipment.
 - D. Federal Communications Commission:
 1. FCC Regulations, Part 15 Title 47.
- 1.4 Submittals
- A. Shop Drawings: Submit in accordance with Section 01300, including the following:
 1. Product and cable specification data sheets.
 2. Main Distribution Frame (MDF) and equipment assembly details.
 - a. Indicate size and space requirements.
 - b. Indicate positions of major components.
 3. Complete wiring diagrams indicating:
 - a. Devices.
 - b. Components.
 - c. Interconnecting wiring.
 - d. Block diagrams
 4. Data base programming sheet indicating all features of telephones, speakers, etc.
 5. Floor plans indicating device and component locations, conduit, raceway and cable routes.
 6. Grounding details and requirements.
 7. Power connections, including source and branch circuit data.
 - B. Operation and Maintenance Manuals: Submit in accordance with Section 01300, including the following:
 1. Component Operating Manual including technical data sheets.
 - a. Control settings.

- b. Amplifier loads.
 - 2. Information for reordering replacement parts.
 - a. Provide a replacement parts list.
 - b. Provide a list of recommended parts, tools, and instruments for testing and maintenance purposes.
 - 3. Wiring diagrams/details:
 - a. System functional block diagrams.
 - b. System schematic diagrams.
 - c. System wiring list.
 - d. Identify terminals to facilitate installation, operating and maintenance.
 - e. Indicate terminals to facilitate installation, operating and maintenance.
 - f. Indicating and distinguish between field and factory wiring.
 - 4. System Operating Instructions: Provide a clear and concise description of operation which gives, in detail, the information required to properly operate the equipment and system.
 - 5. Update to include any information necessitated by construction. Complete "as installed" wiring and schematic diagrams shall be included which show all items of equipment and their interconnecting wiring.
 - 6. Component Service Manual: Include information for testing, repair, troubleshooting, assembly, disassembly, and required/recommended maintenance intervals.
- C. Project Record Documents:
- 1. Submit in accordance with Section 01300 for the complete system. Record drawings shall include and indicate all components of the installed systems, including the routing of conduit, raceways and cable.
 - 2. Drawings shall be coordinated and referenced to the O & M manuals and related wiring diagrams. Floor plan drawings shall be 1/16" = 1'-0" or greater to provide for clear and legible documents.
- D. Test Reports: Submit field test reports specified in Part 3.
- 1.5 Training
- A. Provide all training and utilize specified manuals and record documentation. All training shall be provided at the project site and coordinated with the Owner. All training sessions will be video taped by the vendor for Owner's future reference.
 - B. Training shall include a minimum of two four-hour sessions encompassing all instructions required for system operation. Provide operators manuals and user guides with training. Provide follow up training for 8 hours minimum after initial training.
 - C. Training shall utilize the equipment provided at the project site. Coordinate use, time and availability of equipment with the Owner.
 - D. Demonstrate adjustment, operation and maintenance of the system including each component and control.
 - E. Voice Mail / Homework Hotline: Basic training shall be provided for this system. Additional training for system programming and database management shall be in addition to this contract and will be purchased on an "as needed" basis.

1.6 Warranty and Maintenance

- A. Provide a one (1) year warranty of the installed system against defects in material and workmanship. All labor and materials shall be provided at no expense to the Owner during normal working hours. The warranty period shall begin on the date of system acceptance.
- B. Make available a service contract offering continuing factory authorized service of this system after the initial warranty period.

1.7 Quality Assurance

A. Maintenance Qualifications:

- 1. Experienced in manufacturing equipment of the types and capacities specified for this project.
- 2. Equipment has a record of successful in-service performance.

B. Contractor Qualifications:

- 1. Established communications and electronics contractor for at least five (5) years.
- 2. Authorized distributor for the equipment supplied with full manufacturer's warranty privileges.
- 3. Maintains a fully equipped service organization capable of providing full maintenance and service of the installed system within 24 hours.
- 4. Maintains the necessary spare parts in the proper proportion as recommended by the manufacturer to maintain and service the equipment being installed.

C. Manufacturer's Instructions: Comply with all installation instructions and methods recommended or required by the manufacturer.

D. Reference Standards: Comply with all reference standards indicated in this section as applicable. System shall be UL Listed under UL813.

1.8 System Requirements and Operation

Digital Telephone System

A. The contractor shall provide a complete and satisfactory digital telephone system. All equipment and installation material requirements shall be furnished and installed including the interfaces to intercom and voice mail systems. System being provided is a Remote Campus ECS. The ECC Building will be connected to the Elementary School via fiber.

- 1. Contractor shall provide a microprocessor, stored program control telephone system.
- 2. The system shall employ state-of-the-art digital technology and be in current production.
- 3. All talking circuits shall be balanced transmission circuits.
- 4. System proposed must allow full integration with voice mail.
- 5. All systems must be adequately surge protected based upon stated manufacturer's requirements.

B. Central Switching Exchange: The installation shall include a comprehensive programmable telephone communications system consisting of a digital central switching exchange. The system shall have expansion capability to support up to 448 ports. The following is a outline of the system minimum requirements.

- 1. All programmable functions shall be located in battery backed RAM to prevent loss in the event of system failure.
- 2. The central switch shall utilize standard dual tone multiple frequency (DTMF) decoding in conformance with standard telephone practices.

3. The system shall provide direct dialing, full duplex private telephone communication between all stations equipped with administrative or staff telephones.
4. The system must provide the flexibility of interfacing with all of the following telephone industry standard trunking providing compatibility with existing and future services.
 - a. Loop Start O2LS2: The system must be compatible with existing central office lines.
 - b. Ground Start O2GS2: The system must be compatible with central office GS Lines.
 - c. DID O2RV2: The system must provide Direct Inward Dialing capabilities where direct individual station access over non-dedicated trunks is required.
 - d. OPX OL13C: The system must have capabilities of remote extensions not on the local premise to access all system features.
 - e. E+M Tie Lines TL31M/TL32M: The system shall be compatible with standard PBX signaling for direct connection to an existing or future remote PBX.
 - f. T1 SF/D4 Framing or ESF/D5 Framing: The system shall provide high volume phone traffic capabilities with direct interface without the need for additional interface equipment. Systems requiring additional T1 interfacing equipment such as channel banks are not acceptable.
 - g. CENTREX: The system shall have the capability of interfacing with other outside providers such as Centrex, Watts and Data services.
 - h. ISDN PRI – The system shall have the capability to interface with outside providers via ISDN primary rate interface.
5. Incoming trunk groups shall provide the capability of directing calls to multiple points such as Operator/Attendant, Administrator, Staff or Emergency Lines. The system shall also offer routing, transferring and conferencing of outside trunks to any of the Administrative or Staff telephones. Outside call that are directly go to an Administrative telephone can be automatically transferred to the attendant's station if unanswered within a predetermined amount of time.
6. The system must provide automatic circular hunting for the first available outgoing trunk when placing calls from within the system.
7. The system shall have capabilities for discriminating ringing to enable the receiving party to distinguish between internal and outside calls.
8. The system shall provide Direct Inward System Access (DISA). It shall be possible to access central switch functions (i.e. paging, monitoring, remote activation of time schedules and relays ,etc.) from any offsite touch tone telephone via an incoming telco line. Only authorized individuals may use this feature by dialing the dedicated trunk number and then dialing the system function.
9. The system shall allow for Station Message Detail Recording (SMDR) providing a complete printed record of all calls being placed within the system or when any of the system C.O. lines are accessed.
10. System shall have the capability of connecting in a master/slave configuration with the other building in the complex. System shall house the ISDN PRI cards that will be shared by all systems.
11. Provide the following system features:
 - a. Add On Conference: Allows a station user and/or operator console to add a third, fourth, and fifth internal party to an existing two party conversation.

- b. Alpha-Numeric Display For Attendant Position: A visual device on a console switch, by use of digits and/or alphabetical designation, indicates the trunk circuit to which the attendant is connected, or on internal calls, the station number and alpha/name identification class of service of the station line in voice connection with the attendant.
- c. Area/Office Code Restriction: The ability of the switching system to selectively identify 6-digit area and Office Codes, and either allow or deny passage of long-distance calls to those specific 6-digit codes. This type of restriction is usually provided on a trunk group basis, and on an "allowed" rather than "denied" basis.
- d. Call Forwarding: Allows a station user to program at any time any internal station number (or the attendant), and when activated by the status user, all incoming calls to this station will be automatically rerouted to that preprogrammed number.
- e. Call Forwarding - Busy Line: Automatically reroutes incoming Direct Inward Dialing (DID) calls, attendant processed calls, incoming CCS calls, or direct terminating Tie Line Calls, directly to attendant or predetermined secondary station when the called station is busy.
- f. Call Forwarding - No Answer: Similar in function to the "busy line" version of Call Forwarding, automatic rerouting of a call, DID, or alternate facility to the attendant or a preprogrammed secondary station occurs when a given station does not answer within a prescribed time interval.
- g. Call Transfer: Capability for any multi-line administrative or single line staff telephone to transfer a "call" to any other multi-line administrative or single line staff telephone.
- h. Class Of Service: A numerical index that is assigned to each extension and determines a variety of allowed or denied types of calls on both an incoming and an outgoing basis.
- i. Direct Inward Dialing (DID): A basic facility allowing incoming calls from the public telephone network to reach specific lines without attendant intervention or assistance.
- j. Direct Outward Dialing: The extension user can make external calls without attendant assistance.
- k. Directed Call Pickup: A station user is able to answer calls ringing on any other station by dialing a unique code of that particular station to be answered.
- l. Direct Paging Access: Facilities for telephones which have been software programmed with this capability, to instantaneously distribute page announcements simultaneously to all locations equipped with loudspeakers, by dialing a predetermined code number.
- m. Direct Station Selector: Ability to one-touch transfer calls to intended party while also providing busy status indication of same extension.
- n. Do Not Disturb: A feature allowing incoming calls to an extension to be routed to the call forward destination, other features operate as if the extension is busy.
- o. End-To-End Signaling: Attendant and stations are able to continue to send DTMF signaling over an established external communications path.
- p. Fixed Night Service: An arrangement used to route incoming calls, normally answered at the attendant position, to pre-selected stations with the system when the attendant is not on duty.
- q. Flexible Night Service: Permits the attendant to "set-up" night connections in accordance with day-to-day requirements, with full flexibility in the assignment of incoming trunks to various stations. Such night service arrangements must be established by the attendant on each occasion they are activated.

- r. Flexible Numbering Plan: Station dial plan is user definable to meet the requirements of the owner.
 - s. Hold: The capability to maintain a connection to a busy line, even when the station originating the connection is not off hook to the line or is engaged by another line.
 - t. Last Number Re-Dial: Memory contained either within the system common equipment or within the station instrument enables the station user to dial a special access digit or button to activate a speed calling treatment of the last number which was dialed from that station instrument.
 - u. Message Waiting Indication/Activation: A station user may initiate message waiting lamp indication at another station with button or feature code.
 - v. Programmable Feature Keys: Multiple buttons which can be programmed on a per station basis to access system features with one button access.
 - w. Remote Maintenance: A remote terminal can access the system for maintenance through a modem port or built-in system modem.
 - x. Speed Calling Station: Allows station users to assign abbreviated codes to certain frequently called numbers for use system-wide.
 - y. Speed Call System: Allows attendant to assign abbreviated codes to certain frequently called numbers for use system-wide.
 - z. Voice Mail Integration: Capability of integration to future voice mail system including direct access to intended party's mailbox without entering any digits, message waiting light indication, and access to immediate operator assistance.
 - aa. Call Transfer To Voice Mail: Calls may be transferred directly to any voice mail box from any phone.
- C. Administrative Attendant Console(s): Provide units with the following features. (Quantity as per plans)
 - 1. Ability to distinguish call type and status via a 32-character liquid crystal display.
 - 2. Ability to transfer calls via a single button to stations.
 - 3. Ability to monitor status of all stations in system via a direct station selection (DSS) console.
- D. Multi-Line Digital Telephone(s): Provide units with the following features. (Quantity as per plans)
 - 1. Twenty-Four (24) programmable direct station select "speed dial" keys (buttons) for automatic dialing. These buttons can be initially programmed for C.O. line access, All Call Page, Zone Page, Manual Class Change Signaling and direct station selection of frequently dialed extensions.
 - 2. Feature buttons for a minimum of 8 features.
 - 3. LCD display to show feature use, trunk use, and incoming caller identification.
 - 4. Full handsfree speaker phone.
 - 5. Message waiting indication.
- E. Digital Classroom Telephone(s): Provide units with the following features.(Quantity as per plans)
 - 1. Flash key.
 - 2. Message waiting light.
 - 3. Ringer Volume Control

4. Wall or desk mount as indicated on plans.

F. Digital Door Bell (s): (Quantity as per plans).

VOICE MAIL SYSTEM: Provide system that utilizes recorded voice messages that are accessible from any touch tone telephone, 24 hours a day, 7 days a week. System shall be an option card in the Digital Telephone system. Voice Mail shall provide the following features and functions.

- A. Digital Integrated with the telephone system including customized call forwarding with personalized greeting or transfer capability. Messages left in a users mailbox will light the users telephone lamp automatically. After accessing messages the system will extinguish the user's lamp automatically.
- B. Full or Part Time Automated Attendant.
- C. Voice Mail
- D. Audio Bulletin Board with Information Mailboxes
- E. Outbound Dialing to Phones, cellular services and digital pagers
- F. Distribution and School-Wide Announcements
- G. Ability to capture and announce Caller ID information within each message
- H. A Directory Lookup feature for non users
- I. A Windows based System Administrator Editor
- J. Number of Ports: The system shall have four (8) ports

INTERCOM/PUBLIC ADDRESS SYSTEM

- A. Central Switching Exchange (CSE)
 1. The installation shall include a comprehensive programmable microprocessor-based communications system consisting of a central switching exchange capable of handling up to 360 remote stations.
 2. All programmable functions shall be located in battery backed ram to prevent loss in a power failure condition.
 3. The central switch shall utilize standard dual tone multi-frequency type decoding (DTMF) for conformance with standard telephone practices.
 4. The central switch shall provide an RS-232 port for connection of on or off site programming and or diagnostics. It shall be possible for the user with a personal computer. (IBM XT or compatible) to access and change all system parameters as necessary and to save complete system architecture on its storage medium. It shall also be possible to run diagnostic software to isolate and correct faults in the system.
 5. Provide a one (1) watt amplifier circuit for each remote station to allow absolute flexibility for simultaneous paging, program distribution and time tone schedules. Equipment requiring a single power amp for these functions shall size such an amp as to deliver a minimum of one (1) watt per station. Additional power will be required for hallway speakers, outside horns and common areas.
 6. Provide facilities for a printer output to create a log of system activity.
 7. The system shall be provided with four (4) multifunction ports for administrative phones and or any loop start trunk port of a key or PBX telephone system. All communication between administrative phones or between administrative phones or between administrative phones and loudspeaker locations shall be non-blocking.
 8. Provide capabilities of zoning incoming calls from any staff station location to any of four (4) multifunction ports.

9. Provide four (4) telephonic links between DTMF telephone locations.
 10. Provide eight (8) unrestricted talk paths for private communication between administrative phones, administrative phones and staff stations, and program of time tone distribution.
 11. Provide one (1) direct dialing, two-way voice amplified intercom link with automatic gain control for every twenty-four stations allowing multiple open voice conversations.
 12. Tone Generator: The system shall provide nine (9) built in software definable tones for emergency and routine signaling.
 13. Program Clock: The system shall provide an integral program clock for time tone distribution and other time related functions. It shall be possible to synchronize the program clock from an external master clock.
 14. Clock Schedules: The system shall provide eight (8) separate time-tone schedules with a minimum of 1024 events. Individual events of each schedule shall be capable of sounding one of nine users defined tone types to any of the three hundred and sixty (360) speaker stations. These schedules can be run individually or simultaneously.
 15. Programmable Relays: The system shall provide eight (8) internal system relays which can be activated manually from any administrative phone or automatically activated or cycled via an integral Master Time Control Center for controlling facility wide utility functions.
- NOTE: Systems that do not provide manual control of these relays from any administrative telephone will not be accepted.
16. Audio Program Distribution: The system shall provide facilities for the distribution of three (3) simultaneous audio programs. Program distribution shall be defined from an administrative or staff telephone location. Audio routing shall be accomplished via electronic cross-point switching. Systems which can not distribute program from multiple locations via telephones with the proper access level and require manual activation of mechanical switches at the central control rack only will not be accepted.
 - a. Administrative phones may distribute program by room, by any of the 24 audio groups or facility wide.
 17. Programmable Paging Zones: The system shall provide twenty-four (24) paging zones with two (2) priority levels of all call capability. Paging into any one zone shall not interrupt any program (s) previously distributed. If the areas receiving programs are part of the page zones the program shall be interrupted during the page and returned automatically when the page is completed. These zones are completely separate from the eight (8) zones provided for time signal reception. Any of the three hundred sixty (360) speaker station locations may be programmed to any or all of the systems twenty-four (24) audio zones. Systems providing less than 24 audio zones will not be accepted.
 18. Programmable Extension Numbers: The system shall support two (2), three (3) or four (4) digit programmable architectural room numbers for administrative and staff station locations.
 19. Pre-Announce Tones: The system shall provide selective pre-announce tones for discriminating between pages and intercom calls. A single chime shall be used for pages and a dual chime for intercom calls.
 20. Call-In Confirmation Tone: The system shall provide a call confirmation tone (single beep) at the intercom speaker location when a call is placed. This tone verifies that the call has been placed into the system queue. A second confirmation tone (three beeps) shall be activated if the call is upgraded to an emergency call. Equipment which does not notify the caller that the system has accepted and placed the upgraded call will not be accepted.

21. LCD Display: An operators display shall be provided. This 4 x 20 alpha-numeric LCD display shall continually show time, day, date and current operating time schedule (s) unless it is in the programming mode. In addition, it shall show up to three (3) incoming calls and the priority of each call-in queue (the fourth line shows how many additional calls are pending in the queue). Programming menus, time schedules and complete system architecture can also be displayed when in the programming mode. Menu prompts and feedback tones shall be used to help the user program the system. The operators display shall be capable of operating with any administrative phone on the system.
- B. Standby Power: The system shall be equipped with an Uninterruptible Power Supply (UPS) system to maintain the system in full operation during power outages. All features and functions shall be maintained while on the UPS including interconnect telephone operation. The UPS system shall operate the system for a minimum of 30 minutes during normal usage of the Voice Communication and Sound System. The UPS system shall be mounted on a shelf one (1) foot off the floor.
- C. Diagnostics: The central switching exchange shall provide an RS-232C serial data port for connection to a computer for on-site or via a modem to a remote computer for off-site diagnostic functions by distributor or manufacturer personnel. It shall be possible to determine circuit and software faults via these diagnostic and facilities remote software change. The system shall maintain statistics of operation of the main system functions for use by the individual administering the system.
1. Minimum diagnostic functions shall include:
- Check active list of activity within the system.
 - DTMF test, to check the DTMF registers.
 - I/O diagnostics enable checking of each line, and each device connected in the circuit.
 - Capability of checking each link, and ability to remotely block a link from the system if found defective.
- D. UL Listing: The system shall be UL813 listed meeting the 1990 National Electrical Code (NFPA70).
- E. Program Distribution Panel: The system shall provide facilities for the distribution of three (3) simultaneous audio programs. Program distribution shall be defined from an administrative telephone location. Audio routing shall be accomplished via electronic cross-point switching. Systems which cannot distribute program from multiple locations via telephones with the proper access level and require manual activation of mechanical switches at the central control rack only will be considered to be in direct conflict with the intent of this specification.
1. Administrative phones may distribute program by room, by any of the 24 audio groups, or facility wide.
2. Program sources for distribution shall be:
- Source #1: Provide a rack mounted, quartz synthesized AM/FM Digital Tuner operating on 120 VAC. The AM section shall be tunable over a range of 530 to 1610Hz. The FM section shall be tunable over a range of 87.5 to 108MHz. The tuner shall have seek and scan, 20 preset stations, digital readout and shall include a roof mounted antenna.
- Source #2: Provide a rack mounted Compact Disc Player operating on 120 VAC. Controls shall include play, stop, pause, search, and skip. The CD player shall have a frequency response of 20-20,000Hz + 1dB. Dynamic range shall be 92dB with a total harmonic distortion of 0.007% at 1kHz. A digital display indicating number of tracks, total running time of disc, which track is currently running and its elapsed time shall be incorporated in the player. Auto cueing and random play shall also be standard features.

NOTE: Automobile type combination units are not considered equal in quality.

PART 2 - PRODUCTS

2.1 Acceptable Manufacturers

- A. All bids shall be based on the equipment as specified herein.
- B. The telecommunication system supplier shall be licensed (Alarm and Communications License furnished by the State Board of Electricity) and be an established professional communications system subcontractor with a minimum of five years of continuous service.

Approved system suppliers for this project are:

- 1. Simplex Building Systems

2.2 EQUIPMENT

- A. Alcatel Lucent Omni PCX Enterprise Communications System
 - 1. Simplex 5195 ADIX System
- B. Intercom/Public Address System
 - 1. Simplex 5120 Integrated Communication System

2.3 PBX TELEPHONE SYSTEM

- A. Office Phones #8038
Classroom Phones #8018
 - 1. Simplex Grinnell to coordinate with District for which rooms are to be equipped with administrative and classroom handsets.
- B. Telephone Trunk Ports: Provide ports for the direct connection of 50 central office lines capable of operating with either loop start or ground start trunks for existing and future compatibility with utility services.
- C. Digital Telephone Ports: Provide as required to support quantities indicated. Construct system with 20% spare capacity.
- D. Single Line Telephone Ports: Provide as required to support quantities indicated. Construct system with 20% spare capacity.

MAIN DISTRIBUTION FRAME (MDF)

- A. Provide special cabinet, floor to ceiling, with hinged doors for access to 66 type blocks. Back of cabinet shall have 5/8" plywood to mount 66 blocks. Size as required.
- B. All wire from telephones shall be terminated on 110 type blocks in the MDF cabinet. All circuits in the CSE shall be brought out on 25 pair cables and terminated in the MDF cabinet on 66 type blocks. The 66 type blocks shall then be connected via jumper wires to the 110 type blocks. All circuits shall be identified by room and/or circuit number on the 110 block.

WALL PLATES AND JACKS

- A. See Specification Section 260741.

POWER SUPPLY AND TRANSIENT/SURGE PROTECTION

- A. AC Voltage Supply
 - 1. Separately fused, 110-volt AC circuit fused with a circuit breaker of 20 amps.
 - 2. Protect the AC supply with a Tripp Lite Model ISOBAR (IB) 2.0 AC outlet strip or equivalent.
- B. Grounding: The cabinet housing the CSE and associated sound equipment shall be grounded to the building ground via a #6 AWG insulated copper wire.

- C. Provide the following standby power equipment:
 - 1. TrippLite Model (BX-750) or (BC-1200) battery backup system. Size as required for 60 minutes of operation.

2.4 INTERCOM/PUBLIC ADDRESS SYSTEM

- A. Equipment Rack: Install all sound system components in an equipment rack. Simplex 5100-9810. Unit shall be 61" high with locking rear door. Provide blank panels as necessary to cover excess space. Install the equipment rack (s) on a roller truck with locking wheels to ease servicing and conservation of space.
- B. Central Processor: Provide and install a CPU capable of supporting all speakers indicated on plans. System shall be capable of supporting up to 360 individual speaker zones. Simplex Model 5120 System.
- C. AM/FM Tuner: Simplex 5100-9177 AM/FM Digital Tuner with antenna mounted above ceiling at exterior wall.
- D. Compact Disc Player: Simplex 5120-9184 Compact Disc Player.

PERIPHERAL SYSTEM DEVICES

- A. Backboards: Provide 4'x8' plywood backboards for mounting of system cross connect field mount as shown on the plans. Provide modular termination backboards with 110 type terminal blocks as required to terminate all cables. Provide distribution and cross connect backboards equal to AT&T 110 Series for all cross connect wiring.
- B. Paging Speakers:
 - 1. Ceiling Tile Installation (Round)
 - a. Simplex 5120-9416 8" Speaker, 5 oz. Magnet, 25/70v Transformer
 - b. Simplex 5120-9420 Round White Steel Baffle
 - c. Simplex 5120-9491 Back Box w/ Tile Bridge
 - 2. Wall Mount Installation (Square)
 - a. Simplex 5120-9416 8" Speaker, 5 oz. Magnet, 25/70v Transformer
 - b. Simplex 5120-9430 Square White Steel Baffle
 - c. Simplex 5120-9492 Square Back Box
 - 3. Surface Ceiling Installation (Square)
 - a. Simplex 5120-9416 8" Speaker, 5 oz Magnet, 25/70v Transformer
 - b. Simplex 5120-9430 Square White Steel Baffle
 - c. Simplex 5120-9493 Square Back Box
- C. Horn Loudspeakers:
 - 1. Flush Wall Mount Installation (Square)
 - a. Simplex 5120-9411 8" Loudspeakers
 - b. Simplex 5120-9494 Flush Enclosure w/Baffle
 - c. Provide Weatherproof Where Indicated.
- D. Cabling:
 - 1. Two-way intercom speakers: 2 conductor, 22 AWG, solid, plenum, Green and non-shielded.
 - 2. Commons area speakers: 2 conductor, 18 AWG, stranded, plenum, Green and non-shielded.
- E. Backboards

PART 3 - EXECUTION

3.1 Conduit and Raceway Installations

- A. Provide conduit and raceway systems as specified in Section 260110 f as indicated below.
 - 1. Accessible suspended ceilings: Provide conduit from each outlet to plenum space above ceiling.
 - 2. Non-Accessible ceilings: Provide conduit run from each outlet to cable tray.
 - 3. Exposed structure: Provide conduit run from each outlet to cable tray.
- B. Minimum conduit size:
 - 1. Telephones: 3/4" conduit.
 - 2. Speakers: 1/2" conduit.
- C. Label all conduits at cable tray.
- D. Outlet Boxes: 2-1/8 inches deep, 2 gang with single gang device ring as required for wall construction. Use deep masonry boxes at masonry construction.

3.2 WIRING INSTALLATION

- A. Methods:
 - 1. Install wiring in conduit and raceways except as indicated.
 - 2. Wiring above accessible suspended ceilings may be installed without conduit.
 - 3. Install wiring in cable tray at all locations where cable tray is provided. Route wiring and cable directly to nearest available cable tray.
 - 4. Conceal wiring installations where possible.
- B. Installation:
 - 1. Cable Support: Securely fasten to the permanent building structure where not installed in raceway. Support at regular intervals appropriate to the cable and wire size. Cable and wiring shall not lay loose on ceiling tiles or grids. Install parallel to building lines and follow building structure. Use cable support equipment/hardware recommended by the manufacturer.
 - 2. Cable Pulling: Do not exceed manufacturer's recommended pulling tensions. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between indicated termination, tap, or junction points. Remove and discard cable where damaged during installation and replace it with new cable.
 - 3. Wiring in Enclosures: Bundle, lace, and trim the conductors to terminal points with no excess. Provide and use lacing bars and distribution spools.
 - 4. Identify and tag all cables with permanent type markers to denote location served.
 - 5. Provide cabling and make connection to the telephone company's telephone lines where the service enters the building.
 - 6. Provide a minimum #6 AWG insulated copper ground wire from the main equipment rack to the building main ground bus. Size and provide grounding as recommended by the manufacturer.
- C. Terminations:
 - 1. Splice, Taps and Terminations: Use numbered terminal strips in junction, pull and outlet boxes, terminal cabinets, and equipment enclosures. Tighten connections to comply with tightening torques specified in UL Standard 486A.

2. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors.
3. Rack and terminal cabinet wiring shall be neatly routed or bundled in plastic wiring duct and routed along rack sides. All splices and connections shall be by plug, solder or screw terminal strips, etc. Splices shall not hang in racks or terminal cabinets.

3.3 EQUIPMENT INSTALLATIONS

- A. Surge Suppressors: Where AC power-operated devices are not protected against voltage transients by integral surge suppressors conforming to UL Standard 1449, install surge suppressors at the device power line terminals.
- B. Install and wire equipment in accordance with accepted engineering and installation practices. Only the highest degree of workmanship will be accepted.
- C. Label all front panel controls used in the normal operation of the system using plastic laminate engraved labels, or approved equal. Firmly affix to the panel or device. Dymo or Kroy tap adhesive backed lettering is not acceptable. Refer to Section 260055.
- D. Label each major system component as to function and area served.
- E. Mount system components in cabinets or racks as recommended by manufacturer, except as otherwise indicated.
- F. Arrange equipment to facilitate access for maintenance and working space.
- G. Identify system components, wiring, cabling, and terminals according to Section 260055 "Electrical Identification".

3.4 FIELD SERVICES AND TESTING

- A. Measure the impedance of each amplifier's connected loudspeaker load after all speakers are installed and all transformer "taps" properly set. All room or area volume controls shall be set at "full on" for these measurements. Where more than one zone is connected to the same amplifier, each zone shall be measured individually and then combined. These measurements shall be made with proper test equipment using a 1000 Hz sine wave signal. The results of these measurements shall be recorded for inclusion in the operation manuals.
- B. Where the measurement of any amplifier's loudspeaker load is less than 1.25 times the amplifiers nominal output impedance, make required corrections.
- C. The gain controls of all electronic equipment shall be set as required and then capped or locked into position. Controls which are used for normal system operation are excluded from this requirement. All control settings shall be recorded for inclusion in operation manuals.

3.5 FINAL CHECKOUT AND ACCEPTANCE

- A. System shall be complete and fully operational before requesting final acceptance and scheduling system demonstration/training.
- B. Final Acceptance of the system will be given upon completion of all of the specified requirements, including testing, training and demonstration, and submittal of all required documentation.

3.6 EXTRA DEVICES

- A. In addition to the equipment shown on the project drawings, include the quantities of the components shown below. These devices may be installed at the discretion of the Owner, Architect or Engineer. If necessary, these devices, along with the required panel additions, wiring, labor, etc., shall be furnished and installed at no additional cost to the Owner. If, at the end of the project, they are not required to be installed, they shall be given to the Owner for their use.

<u>Qty</u>	<u>Description</u>
3	Classroom Telephones
3	Classroom/Office Speakers
1	Administrative Telephone
3.7	EXECUTION
A.	All work under this section shall be performed by persons having specific familiarity with telephone, data, and sound system installation. Upon request, the contractor shall submit resumes, references or other corroborating documentation, to the engineer to confirm the contractor's capabilities and experience.
B.	GROUNDING: Except where specifically indicated otherwise, all exposed non-current carrying metallic parts of the communications system shall be grounded. This may be accomplished via a driven ground rod, cold water pipe or building power ground. If the building power ground is used, a separate ground conductor shall be used from the equipment to the grounding grid. All grounding shall be done with #6 solid copper wire or larger. The contractor shall use every effort to insure system stability and safety.

END OF SECTION 26 0771

SECTION 26 07 73

CLASSROOM AUDIO, SAFETY & INTERCOMMUNICATION SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The requirements of the contract documents, including the General and Supplementary General Conditions and Division 1 – General Requirements shall apply to the work of this section.
- B. At the time of proposal, any exceptions taken of these specifications, all variances from these specifications and all substitutions of operating capabilities or equipment called for in these specifications shall be listed in writing and forwarded to the Architect / Engineer. Any such exception, variances or substitutions which were not listed at the time of bid and are identified in the submittal, shall be grounds for immediate disapproval with comment.

1.2 SCOPE OF WORK

- A. The work covered by this section of the specifications shall include all material, labor, hardware, software, firmware and programming to install a completed and operating system as described herein and shown in the drawings. The system shall utilize the schools shared data network, and not require the use of any proprietary switches, routers, or other network components. The physical network components shall be provided by the owner or the contractor, the scope of this document does not include the physical network including switches, routers, or network cabling. Beyond the shared data network hardware, the rest of the system shall be complete with all necessary materials, labor, hardware, software, firmware and programming specifically tailored for the installation. It shall be possible to permanently modify the software on site by using a system administrator software network interface.
- B. The intent of this specification is to maximize communications between the classroom and administrative areas utilizing VoIP (Voice over Internet Protocol) Technology while enhancing school safety and reducing maintenance, operational, and installation cost.
- C. Under this specification, the system shall provide a complete VoIP Communication System for the all classrooms and flex spaces as indicated on the drawings. An analog solution using speakers and volume controls in the offices, corridors, exterior locations, restrooms, gymnasium and cafeteria shall also be part of this project.
- D. The Communication System shall provide VoIP or network distribution of intercom, overhead paging, emergency paging, class change time tones, emergency tones and program material.
- E. Any and all miscellaneous materials, labor, hardware, software, firmware and programming that is not listed in the specification section that is required to provide a complete and operating system shall be provided as part of the scope of work for this installation.
- F. The work covered by this section of the specifications shall be coordinated with any and all trades that are affected by the installation of this system. All work is to be complete and as required and specified elsewhere under these project specifications.
- G. All the actual required system components and cabling are not shown or specified as this carries between acceptable manufactures and suppliers. It shall be the responsibility of the contractor to obtain this information from the acceptable supplier and or manufacturer and include the cost of the same in his bid.

1.3 APPLICABLE CODES AND STANDARDS

- A. All devices of the system shall be listed by UL (Underwriters Laboratory). All components of the system shall bear the UL label.

- B. The system shall be installed in strict accordance with all the requirements of the National Electric Code.
- C. The system shall be installation in strict accordance with the requirements of the Americans with Disabilities Act (ADA).
- D. The system shall be installed in strict accordance with the requirements of all other applicable codes as well as all Federal, State, and local codes.

1.4 RELATED DOCUMENTS

- A. Secure any and all required permits and approvals prior to installation.

1.5 RELATED WORK

- A. The contractor shall coordinate work in this section with all related trades that the system effects of integrates with. Work and / or equipment provided in other sections and related to the system shall include but not be limited to the following:
 - 1. Cable support system
 - 2. Structured Cabling System installer
 - 3. Network Infrastructure Supplier – switches/routers

1.6 SUBMITTALS

- A. Furnish to the Architect / Engineer complete equipment submittal technical specification sheets and shop drawing submittals in .pdf format for this system including but not limited to the following:
 - 1. A material list with the quantity of each piece of equipment, names of manufacturers, model numbers and the technical data information on all equipment the contractor proposes to install. This material list is to be broken out and listed by Specification Section, per piece of equipment. If a piece of equipment is needed but not listed in this specification section, it shall be listed in the area of the submittal it pertains to. The technical information is to be a piece of the manufacturers printed literature that is produced by the equipment manufacturer. Internet web page listings will not be accepted. Provide a description of any special installation procedures that will differ from what is specified or shown on drawings.
 - 2. Complete system circuit diagrams of the entire system, point to point on scaled floor plans scaled to match that of the scale of the project documents. The shop drawings are required to clearly illustrate how all components related to each other and how they interconnect to each other. A complete point to point wiring diagram of any and all panels and how they interconnect with all the components and or devices that are part of the system as well as any ancillary devices that are being provided by other trades. All cables run are to be shown of the shop drawing submittals. Cable tags shown on the shop drawing submittals shall correspond with cable tags that are located inside equipment enclosures as well as documented on the as-built drawing. The shop drawing submittals shall include scaled drawings of all racks, panels, consoles and special assemblies. The show drawing shall include all circuit numbers of all cables and terminal connections as well as how they are labels. Each drawing shall have a descriptive title and all subparts of each drawing shall be completely described. All drawings shall have the name of the project, Architect / Engineer and contractor in the title block. The floor plans, rooms names and numbers for the submittal drawings are to match that of the project documents. The symbol used on the submittal drawings are to match that of the project documents. The only information to be shown on the submittal drawings for this Specification Section shall be information that pertains to the system that is being submitted on.
 - 3. Provide a custom detailed description of the operation of the submitted system for this particular installation and a statement listing every technical and operation parameter wherein

the submitted equipment varies from what was originally specified. If the submitter fails to list a particular variance and his submittal is accepted; but subsequently, deemed to be unsatisfactory because of the unlisted variance, the submitter shall replace or modify such equipment at once without cost to the Owner. A letter or certificate from the manufacturer stating that the system contractor is an authorized distributor and installer of the submitted equipment shall be supplied.

4. The contractor shall be responsible for providing to the Architect / Engineer any and all additional information required and as deemed necessary by the Architect / Engineer for submittal and shop drawing submittal review.

1.7 QUALITY ASSURANCE

- A. This specification section shall be a one (1) manufacturer responsibility or as specified herein with no exceptions. Any variances to this specification item shall be submitted to the Architect / Engineer ten (10) working days prior to proposal for review by the Architect / Engineer. The equipment manufacturer for this specification section to have been in business and manufacturing the specified equipment for a minimum of ten (10) years.
- B. The contractor shall be the factory authorized and factory certified distributor and installer of the equipment to be provided for this specification section. The installation contractor's factory certification is to be submitted to the Architect / Engineer as part of the contractor's subcontractor and materials list at the time of the bid as well as with the shop drawing submittal.
- C. The contract for the systems described herein will be assigned to the general contractor for the building construction. The intercommunication system contractor shall coordinate all work and work sequencing with the general contractor.
- D. Owner and Architect / Engineer Inspections: The Owners technology staff and Architect / Engineer shall provide advising as requested. The Owners technology staff shall inspect the project as the work progresses. Prior to final acceptance of the work, the Contractor shall make arrangements with the appropriate authorized Owner personnel to inspect the construction areas, both to ensure satisfactory completion of the work and to ensure complete cleanup and restoration of areas affected by the work. Temporary protection, coverings, and structures shall be removed at or before time of inspection.

1.8 CIRCUITING GUIDELINES

- A. All wiring shall be Cat. 6/6a for connections to speakers, call switches, etc... for future migration to a complete IP (Internet Protocol) based intercom paging system. Cabling from the MDF or IDF to each classroom enclosure shall be provided by others. A patch cable, providing connectivity from the work outlet faceplate to the MS-500 shall be provided by others to the AV contractor for connection to the network.
- B. Each classroom / education space to have a dedicated network connection to the intercom paging system head-end to provide 2-way communications from the building telephone system handset to each classroom / education space individually.
- C. Each office / administrative space to have 1-way communications from the paging system and be capable to being addressed from the building telephone system handset.
- D. Each corridor / common space / exterior space including library, cafeteria and gymnasium to have 1-way communications from the paging system and be capable of being addressed from the building telephone system handset.
- E. All wiring shall be in accordance with the Manufacturers specifications.

1.9 SEQUENCE OF OPERATIONS

- A. The ability to be distributed via a fiber 10/100/1000MB switched, VLAN enabled network or

- 10/100/1000mB switched stand-alone intercom network. It shall be possible to eliminate the need for copper feeder cables between the Main and Intermediate distribution frames through the use of fiber optics.
- B. Shall have SIP (Session Initiation Protocol) Integration to connect all talk-paths to the VoIP phone system of choice.
 - C. The system shall provide the ability to support a SIP tunnel from the building's VoIP phone system to provide two-way communication from all administrative telephones to any location equipped with a talkback speaker or audio system with room microphone.
 - D. System shall interface with any VoIP telephone system using SIP type integration thus allowing the school(s) to upgrade or replace their telephone system without suffering a requirement to replace, or lose any feature of, their internal communications (intercom) system. Any system that limits system features based upon any selected telephone system and is not SIP based shall not be acceptable.
 - E. Automatically sound a tone or play a pre-page WAV file over any loudspeaker connected for two-way communication to alert the classroom teacher that this 2-way call has been established. This is intended to prevent unauthorized monitoring.
 - F. Distribution of emergency announcement(s) from any authorized telephone to all areas furnished with a loudspeaker. Emergency announcements shall have the highest system priority
 - G. Distribution of general announcements from any administrative telephone, staff telephone, or classroom telephone. The system shall be capable of providing all-call, group call, or multiple group call.
 - H. Classroom speakers or audio systems with room microphone shall be software assignable to unlimited paging groups.
 - I. Provide the ability to define and archive unlimited schedules with up to three hundred (300) events per schedule. Each scheduled event shall be capable of activating included tones or playing custom audio/voice phrases or controlling any I/O port on a system network interface for building control. Schedule administration, modification and creation functions shall be available through web access on remote computers and mobile devices.
 - J. The system shall provide an administrative console for the front office, consisting of a touch screen interface no less than 22" diagonal interface.
 - K. The User Interface will be map based. The manufacturer shall provide the ability to take a map in any format, including paper copy, PDF, Visio, etc. and create from that the map used for the primary user interface. Non map based User Interfaces will not be considered.
 - L. The WAV or MP3 files shall be activated via the administration software, telephone and / or telephone system and / or pushbuttons.
 - M. The WAV or MP3 files shall be programmable as to what level of priority they can be broadcast. They shall be programmable as to override any class change tones, normal all call, music, and intercom in the event of an emergency.
 - N. The WAV or MP3 files shall also have the ability to be broadcast into any one or all of the zones with the system.
 - O. The WAV or MP3 files shall have the ability to be broadcast via a schedule for any day of the week or time of the day. They shall also have the ability to be broadcast for any duration of time and repeat number of plays with the ability to select how long the duration is between each repeated broadcast.
 - P. The WAV or MP3 files shall also have the ability to be a part of the classroom change tones within the system. These files shall be able to replace any tone within the class change schedules as to

offer the flexibility of customizable tones and or phrases in this class change mode.

- Q. It shall be possible without the cost of additional hardware/software to incorporate a LAN / WAN district wide paging system by means of the built in VoIP district Paging Adapter or district software. This adapter shall give the district the ability to page each school independently, as a group of schools, or all schools.
 - R. The system shall allow for the integration of changeable message signs to support bells and notifications. These signs shall be multi-color, multi segment LED scrolling displays and powered and controlled via a network PoE (Power over Ethernet) connection.
 - S. The system shall also allow for the integration of third-party system through the use of contact closure, TCP (Transmission Control Protocol) communication, RS-232 communications and HTTP (HyperText Transfer Protocol) communications.
- 1.10 WARRANTY
- A. The manufacturer and installation contractor shall guarantee the system, equipment and all its components for a minimum of two (2) years from date of final acceptance of the system as documented by the Architect / Engineer. This guarantee shall cover the replacement of all parts and labor to replace the same made necessary by normal usage and wear.
 - B. Upon completion of the installation of the system, the contractor shall provide to the Architect / Engineer and Owner a signed written statement, on company letterhead, substantially in form as follows: "The undersigned, have engaged as the Intercom paging system contractor for the _____ building project confirms that the system was installed in accordance with the wiring diagrams, instructions and directions provided by the manufacturer."
 - C. Contractor shall repair, adjust, and / or replace, whichever the Owner and / or Architect / Engineer determines to be in its best interests, any defective equipment, materials, or workmanship, as well as such parts of the work damaged or destroyed by such defect, during warranty period, at the contractor's sole cost and expense.
 - D. In the event that any of the equipment specified, supplied, and / or installed as part of the work should fail to produce capacities or meet design specification as published or warranted by the manufacturer of the equipment involved or as specified in this document, the contractor shall, in conjunction with the equipment manufacturer, remove and replace such equipment with equipment that will meet requirements without additional cost to the Owner.

1.11 TRAINING AND INSTRUCTION FOR OWNER MAINTENANCE

- A. A training program including a minimum of four (4) hours on the use of the system shall be provided to the Owner to use at their discretion. A full and complete overview of the system shall be included in this training as well as any literature required by the Owner to allow complete and total use of the system by the Owner's designated staff. System maintenance requirements for the equipment will also be documented and turned over the Owner. This training shall be recorded and archived in CD/DVD format and turned over to the Owner for archiving purposes. The Contractor shall provide any required materials and staff to record the training.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. The following manufacturers are approved to submit proposals for this project:
 - 1. Audio Enhancement – EPIC System

2.2 EQUIPMENT

- A. Intercom Paging System:
 - 1. The system shall be a software-controlled system, whose primary interface is a web-based

- portal, accessible from any authorized computer. The system shall utilize a 1U rack server, operating as an appliance, dedicated to the operation of the IPB (Intercom Paging and Bells) & SAFE (Signal Alert For Education) System only. The rack server shall have industry standard redundancy, including RAID1, Dual Power Supplies, and hot swappable hard drives. The entire system shall be Linux based.
2. The system shall be SIP Integrated to the VoIP telephone system.
 3. The system shall provide a simple calendar-based scheduling system for bells. It shall provide the ability to have an unlimited number of bell schedules
 4. The system shall provide a map-based User Interface. All major functions, including Intercom, Paging, Notifications and Alerts shall be done using the map as the foundation for those actions. Paging shall clearly show on the map where the page audio will be transmitted to.
 5. Bell Schedules shall be easily assigned to days and changed simply with authenticated access to the system through any browser-based device.
 6. The system shall utilize a shared data network (VLAN [Virtual Local Area Network] enabled) or dedicated network as means of distribution for all voice overhead paging, emergency paging, emergency tones, intercom, and class change tones.
 7. The system shall be capable of accessing remote classrooms (trailers, temporary classrooms etc.) via IP interface or room audio system with room microphone. This shall provide intercom, class change tones, emergency tones, and normal / emergency paging via a wired network to these remote locations.
 8. Exterior speakers shall be capable of being on separate zones and programmed separately.
 9. Ability to synchronize to the same NTP server utilized for the Master Clock system.
 10. Ability to produce user defined tone signals for time tones or emergency tones.
 11. The system shall have SIP Integration to connect all talk-paths to the VoIP phone system of choice.
 12. The system shall provide the ability to support a SIP trunk from the building's VoIP phone system to provide two-way communication from all administrative telephones to any location equipped with a talkback speaker or audio system with room microphone.
 13. System shall interface with any VoIP telephone system using SIP type integration thus allowing the school(s) to upgrade or replace their telephone system without suffering a requirement to replace, or lose any feature of, their internal communications (intercom) system. Any system that limits system features based upon any selected telephone system and is not SIP based shall not be acceptable.
 14. The system shall provide its own SIP environment, and in the case of a failure of the schools VoIP telephone system, be capable of operating completely independently for all functions, save access from the handsets connected to the schools VoIP system.
 15. Provide web access, which will give ability to monitor operations and functions of the system.
 16. Provide web-based off-site programming and diagnostics of the system. It shall also be capable of determining basic circuit faults.
 17. The system shall have a Web based administration programming tool which allows the administrative personnel to easily manage Audio Sources, Class Change schedules, paging groups, time updates, holiday schedules and day/night mode operation from an internet browser.
 18. The system shall provide calendar-based scheduling up to four years in advance. The system shall be capable of displaying a fully year calendar and differentiating which bell program is

- scheduled to run on each day. The calendar shall be based on a standard school year and provide a selectable start month for example, it can be configured to run from August to July.
19. The system shall be capable of being fully integrated with the school's existing LDAP (Lightweight Directory Access Protocol) or Active Directory system. Systems that do not provide LDAP or Active Directory integration shall not be considered.
 20. The system shall provide discreet control over roles for the system. Roles shall be definable down to the individual feature level and provide the district with the ability to restrict or grant access to any roll individual features or groups of features.
 21. The system shall provide web browser access to the system specifically for a teacher. Teacher access shall be assigned through LDAP or Active Directory. The Teacher screen shall provide information specific to the room that the teacher is assigned to. That information shall consist of, but not limited to, the next scheduled event for the room (Bell, Announcement, etc.), Audio/Visual Controls for their classroom technology, Teacher Name, Room Number, an Intercom Call button, and an Emergency call button.
 22. The system shall have the ability to carry IP Communications to the edge of the classroom Audio/visual Systems. It shall be able to control connected A/V Devices, provided that those devices are controllable by RS-232.
 23. The system shall be based on a database structure, utilizing a robust commercially available database such as SQL(Structured Query Language).
 24. The system shall provide 2-way handsfree communication in each classroom.
 25. System Classroom and Common Zone network interfaces shall be capable of utilizing standard Cat 6/6a infrastructure for installation from the Telecommunications Closets only to the classroom and/or zone, thus allowing for only one type of wiring infrastructure within the school. Distribution of all voice signaling shall utilize a shared or dedicated network. Systems that require homerun, dedicated, 18 gauge shielded wiring shall not be acceptable.
 26. The system shall provide a flexible and robust event engine, and in addition to pre-programmed events and actions, the event engine shall be capable of accepting Java based programming to accomplish advanced integrations and functions.
 27. The system can automatically broadcast page emergency instructions throughout an entire school when an alarm (e.g. lockdown, lockout, security, fire) is tripped or manually activated. The emergency instructions shall be preprogrammed and require no user intervention. The system shall provide redundant alarm annunciation over intercom/paging speakers and is not meant to replace primary fire alarm or security systems.
 28. The system shall provide the ability for the school to upload their own recorded files for both Bell Tones, and Notifications
 29. The platform shall provide the ability to initiate school safety paging announcements, evacuation tones and take cover tones from any telephone within the facility or outside the facility to any other location within the facility or district.
 30. IP-enabled two-way voice communication shall be available from any provided telephone or administrative console through any speaker in the system. This shall allow hands-free communication to any classroom or any individual loudspeaker unit. A pre-announce tone shall sound immediately before the intercom path is opened.
 31. The system shall provide for a complete personal alert function for each teacher. The alert functionality shall be an integrated part of the administrative head end software and shall not require any separate application or hardware to support this functionality.

32. The teacher personal alert functionality shall be integrated into the classroom microphones and the teacher web screen.
 33. The system shall be capable of displaying on the map the location of the alert in the case of a microphone that is within range of its paired receiver, or from the teacher's web access screen. The system shall also be capable of approximately locating the location of the alert in the case of a microphone that is not in range of its paired receiver. A system, either the microphone system, or the administrative system that is not capable of receiving an alert from a microphone that is not within range of its paired receiver shall not be considered.
 34. Upon alert, the system shall have the ability to provide notification on the dedicated console at the front office, or on any other computer which is currently logged into the administrative interface and has the appropriate credentials. The system shall provide both an audible tone, and a change on the screen that clearly indicates that an emergency alert has been received.
 35. Upon alert, the system shall also be capable of sending e-mail and SMS Text messages to the designated school personnel. These alerts shall include a web link to the administrative console.
 36. If cameras are installed in the classrooms, the system shall be capable of showing a live video from the classroom that received an alert. This shall only be shown in the case of an alert where the microphone is within range of its paired receiver.
 37. The system shall have the ability to acknowledge the receipt of the alert by changing the indicators on the classroom microphone receiver in the room where the alert was received from. In the case of an alert received from a microphone not in range of its paired receiver, no acknowledge shall be sent.
 38. The system shall have the capability of maintaining a record of all alerts that are received and provide appropriate school personnel the capability to enter information about the alert, which shall be maintained in the systems database. That information shall also be made available to appropriate school personnel in the form of a report that shows all alerts that have occurred, their date, time, and the end alert information.
 39. The system shall contain a rules-based integration engine that allows for input of TCP, HTTP, or Serial Data and allows for the parsing of data for actions or triggering other systems via TCP, HTTP or Serial.
 40. The system shall support digital message displays that provide visual feedback in the form of scrolling messages via an LCD or LED display all controlled from the network.
- B. Intercom Paging System Network Intercom Interface:
1. Shall allow users to install intercom paging systems spanning multiple building or facilities connected through a VLAN.
 2. Network Requirements:
 - a. 10/100 Ethernet switch port configured on a dedicated VLAN.
- C. Intercom Paging System Power:
1. All Network interfaces used in the classroom and for the common zones shall be powered via PoE from the district provided network switches.
 - a. PoE switches and network cabling from MDF (Main Distribution Frame) and IDF (Intermediate Distribution Frame) to devices provided by others.
- D. Intercom Paging System Administrative Console Software:
1. The administrative console shall be customizable, flexible and provide full access to the intercom paging system.
 2. The supplier is required to provide a dedicated touch screen console for the front office, with a

- minimum size of 22" Diagonally. The Console shall not require the district to provide any additional hardware, software or licensing. The Console shall also provide a boom microphone attached via USB to the console for paging/intercom use.
3. Administrative access to the system shall be browser based and shall also be capable of being any administrative computer.
 4. Functionality to provide full access to all features such as all call, paging groups, emergency tones, control music, WAV file distribution, test rooms, crisis mode, schedules, etc...
- E. SAFE SYSTEM & NETWORK PAGING INTERFACE - Audio Enhancement, MS-300
1. Provide a Network Interface with performance as follows:
 - a. Full-Duplex, Hands Free communications on Intercom Call
 - b. Amplifier powered only by the PoE power source for emergency paging applications, support IEEE 802.3af and 802.3at
 - c. Mounting Bracket as required
 - d. Connections – The following connections shall be available:
 - (1) Line Output for connecting to auxiliary amplifiers
 - (2) 2 External I/O Connections – 8P8C (RJ45)
 - (3) Wall Plate Terminal 8P8C (RJ45)
 - (4) 8P8C (RJ45) for PoE Network Connection
 - e. 1 speaker connection
 - (1) The system shall provide a speaker connection which is powered exclusively by the PoE power from the network
 - f. Network Connection
 - (1) The system shall have a network connection with PoE power.
 - (2) PoE shall be present on the system in order to provide power for the amplifier during a power emergency
 - g. Integrated Network Based Communications
 - (1) The System shall support the following protocols:
 - (a) Directed UDP (User Datagram Protocol)
 - (b) Unicast Audio
 - (c) Multicast Audio
 - (d) SIP
 - (e) TCP Control
 - h. Integrated Serial Tunnel over TCP
 - i. The system shall have integrated SIP communications and be able to communication bi-directionally with any VoIP communications system that follows the standard SIP protocols.
 - j. The system shall also have the ability to operate with multi-cast IP messages as well.
- F. Analog Intercom System Cabling:
1. West Penn
 2. Belden
 3. General Cable

4. Mohawk
 5. Accepted substitute
- G. Intercom Paging System Volume control:
1. Volume control shall be capable of controlling the volume of up to one hundred-fifty (150) 1-way speakers.
 2. Volume control shall be mounted on a brushed stainless-steel single gang wall plate with the plate being embossed with a dial scale of "0 through 10."
 3. Volume control shall be equipped with a skirted black knob with white position indicator.
 4. Volume control shall include a stainless-steel mounting box and hardware.
- H. Intercom Paging System Lay-In Ceiling Speaker.
1. Lay-In Specifications
 - a. Lay-in ceiling speaker shall consist of a white 1'x2' perforated grille, a speaker and integral back box or equivalent ceiling speaker with appropriate backbox, grille and tile bridge.
 - b. The volume control is accessible above the grid
 - c. The speaker shall be capable of handling minimum 35 watts continuous power.
 - d. Sound pressure level at 1 meter on axis with a 1 Watt input shall be 95 dB.
 - e. The frequency response shall be 70 Hz to 17 kHz.
 - f. The baffle shall be constructed with a single piece of perforated steel with a white baked on acrylic enamel finish.
 - g. The back box shall meet or exceeds UL 2043 for installation in a plenum space
 - h. Maximum dimensions of the grill shall be 2' x 2' (60.96 cm x 60.96 cm).
 - i. Weight shall be approximately 5.5 lbs. (2.49 kg).
- I. Intercom Paging System Surface Wall Speaker:
1. Wall speaker shall consist of a speaker, volume settings and sloped baffle.
 2. The speaker, housing and hardware shall be electrically and acoustically matched for a frequency response of 60 Hz to 12 kHz.
 3. The speaker shall be 8" (20.32 cm) in diameter and have a ceramic magnet weighing 5 ounces.
 4. The voice coil shall be .75" (1.91 cm) in diameter.
 5. Voice coil impedance shall be 45 ohm.
 6. Operating temperature shall be -20 to + 55 °C (-40 to + 131 °F).
 7. The baffle shall be constructed of gray painted steel with a black cloth grille.
 8. Maximum dimensions of the housing shall be 10.13" (25.73 cm) H x 12.31" (31.27 cm) W x 4.63" (11.75 cm) D.
 9. Approximate weight is 4.25 lbs (1.91 kg).
- J. Intercom Paging System Paging Horn:
1. Shall be a weather-resistant, high efficiency reentrant type horn speaker.
 2. Shall be equipped with an amplifier and externally accessible volume control.
 3. Shall include an adjustable swivel base.
 4. The frequency response shall by 275 Hz to 14 kHz.
 5. Dispersion shall be 90° horizontal and 90° vertical.

6. Sound pressure level shall be 121 dB measured at 4 feet (1.22 m) on axis with an input to the amplifier module being -10 dBm at 1 kHz.
7. Distortion shall be less than 2.0% at rated output of 15 watts RMS.
8. Input impedance shall be 600 ohms nominal.
9. The amplifier shall operate on a -24 Vdc nominal, positive ground power supply.
10. Operating current shall be 900 mA at -24Vdc
11. Operating temperature shall be -4 to 131 °F (-20 to 55 °C).
12. Operating humidity shall be 0-95% noncondensing.
13. Dimension of the horn shall be 8" (20.3 cm) W x 8" (20.3 cm) H x 9" (22.9 cm) D.
14. Weight shall be approximately 4.0 lbs (1.8 kg).

K. Classroom Sound Reinforcement System:

1. Audio Enhancement – Optimum System
2. A classroom sound reinforcement system shall be installed in all areas of the building as shown on the drawings and as listed in the specifications.
3. Classroom sound reinforcement system shall be fully interfaced to the intercom paging system.
4. The output of the intercom paging system shall directly interface to the classroom sound reinforcement system.
5. The sound reinforcement system shall be capable of integration with the facility intercom/paging system. All sound reinforcement systems shall allow the facility intercom/paging system to directly mute them. The Receiver Module shall have the capability to sense a paging signal from the facility communications system. When a page has been sensed, the classroom sound system shall mute local audio to facilitate hearing the facility page.
6. This integration shall give positive control when interfaced to the classroom sound reinforcement system within the system as to cut off or duck all sources within the classroom when an intercom or page announcement is made from anywhere within the school.
7. The classroom sound reinforcement speakers shall be used as the intercom paging system speakers.
8. The intercom paging system speakers shall be connected to receive audio from any of the in-room sources and receive audio from the intercom paging system.
9. The classroom sound reinforcement system shall be mounted in a wall mount enclosure, specifically designed which allows the microphone receiver to remain visible through the door of the enclosure
10. The DECT (Digital Enhanced Cordless Telecommunications) based microphone receiver shall be capable of being mounted directly to the enclosure and connecting to the amplifier utilizing Cat. 6/6a cable.
11. Each microphone input shall have a carrier detect indicator to verify the input is active.
12. The classroom sound reinforcement system shall have a secondary line level output to connect to self-amplified speakers or other audio equipment if needed.
13. The classroom sound reinforcement system shall have an emergency cut-off input that when interfaced to the fire alarm relay contact output shall silence all audio devices within the room in the event of a fire as to help lower the overall decibels levels to help the students and staff hear the audible fire alarm tones / instructions within that room.

14. The classroom sound reinforcement system shall be capable with interfacing to future classroom cameras to capture lesson video and audio together on one recording.
 15. The Wireless Microphone shall be capable of adjusting the volume of external audio sources that are connected to the Main Control Unit. The Wireless Microphone shall be powered by a single rechargeable LiON (Lithium-ion) battery which can be charged inside the microphone via a standard USB cable. The Wireless Microphone shall be able to operate for up to a typical eight (8) hour workday on a single charge.
 16. Each classroom sound reinforcement system shall include but not limited to the following components:
 - a. DECT Based receiver
 - b. Amplifier & Network Interface
 - c. Two wireless microphones with rechargeable LiON batteries
 - d. Four (4) FS-17 Flat panel ceiling speakers (S2)
- L. Classroom Sound Amplification System (CSAS) EQUIPMENT:
- AMPLIFIER - Audio Enhancement MS-500 Amplifier/Network Interface:
1. Provide a fully PoE Powered Receiver/Amplifier with ability to provide functions described above with performance as follows:
 - a. Audio Power: 30 watts RMS mains powered amplifier
 - b. 92% Efficient Class D Amplifier
 - c. 1% percent THD across full frequency range of amplifier
 - d. Frequency Response: 20 Hz to 20 kHz
 - e. Power Requirements: PoE 802.3af/at 25.5W Maximum
 - f. Signal-to-noise: >89dB
 - g. Integrated mounting tabs
 - h. Thermal and short circuited protected
 2. Controls:
 - a. The primary control of the system shall be done through the teacher microphone.
 - b. The following functions shall be available via USB connection for setup during installation:
 - (1) Input Control for multi-media sources and mixed IR source
 - (2) Equalizer Controls
 - (3) Discreet Output volume controls for each input
 - c. RS-232 Control
 - (1) Provide RS-232 control of the amplifier, and an additional RS-232 port which provides pass through control of a downstream device such as a projector
 - (2) RS-232 processor shall be capable of differentiating between commands destined for the amplifier, and responding to those commands, and commands intended for the downstream and passing those commands through to the secondary RS-232 port
 - (3) Command pass through shall be bi-directional
 - d. Connections – The following connections shall be available:
 - (1) Four (4) Multi-Media inputs

- (2) Dedicated Line output – for Assistive Listening Device Connection
- (3) Color Coded Connection
- (4) 8P8C RJ45 Connection for Intercom Paging Wall plate
- (5) Support for Touch Based Wall Controller on Remote Port
- (6) General Purpose I/O Output on 8P8C RJ45

M. DECT Technology RF Receiver – Audio Enhancement SRC-14

1. The Receiver shall utilize DECT technology. DECT is a radio technology for voice applications. DECT is ideal for the classroom because the use of both frequency and time domain is ideally suited to smaller areas with a large number of users. In each classroom, it will be an independent system, with all necessary electronics to support the receiving & pairing functionality mounted on the wall near the amplifier or in the ceiling. The receiver will be connected to the amplifier through a universal twisted pair cable, using balanced audio connections. Power for the receiver shall be provided through the same cable as the balanced audio connections.
2. The receiver shall provide the following functionality. These features shall be included on board the receiver, and not require any external support to perform these functions.
 - a. Three Channel DECT based reception
 - b. The receiver shall provide both a low and high-power mode selectable via a DIP (Dual In-line Package) switch
 - c. Pairing Button for Linking microphone to the receiver
 - d. External contacts to allow for a remote pairing button
 - e. Stereo Auxiliary Input
 - f. Auxiliary Line Level Output – Un-Balanced
 - g. Remote control of both microphone channels, and the auxiliary input from the teacher microphone
 - h. Public address system mute terminals – This is a contact closure connection when closed, it mutes the audio output from the receiver
 - i. Advanced Feedback Blocker
 - (1) The system shall have the ability to actively control feedback. This shall be done via an analog circuit that provides up to five active filters to control specific frequencies,
 - (2) The Feedback Blocker shall also have the ability to lower the overall of the system by up to 6dB, during a user error situation where the overall system gain is manually turned up too high
 - (3) The Feedback Blocker system shall automatically remove the filtering upon resolution of the user-initiated error condition
 - (4) The Feedback Blocker shall be of an analog design – in order to avoid the detrimental effects of digital sampling, only analog systems shall be considered in order to implement this feature.
 - j. Audio Output
 - (1) The system shall have the ability to provide both three (3) independent audio signals (Ch 1, Ch 2, and Aux) or with the change of a DIP switch, provide a mixed signal
 - (2) The system shall provide an audible tone when the remote volume control on the teacher microphone is used. It will also provide a low & high output level, and an

on/off selection via a DIP switch setting

- (3) The system shall have the capability of attenuating its output level by -10 dB with a DIP switch setting

k. Emergency Alert Contacts

- (1) The system shall provide a trigger signal when the teacher presses and holds a button on her transmitter for more than two (2) seconds.
- (2) The system shall be capable of providing a visual indication of three (3) red LED's when the teacher initiates a trigger signal
- (3) The system shall also be capable of receiving a trigger acknowledgement signal back from an external source, and altering the visual indicator from three (3) red LED's to two (2) Green and one (1) red LED

l. Recording Contacts

- (1) The system shall provide for a secondary notification that can be used for future applications such as signaling an NDVR (Network Digital Video Recorder) to start a recording

m. Control System Integration

- (1) The system shall have on board the capability of being controlled via RS-232 protocol.
- (2) The system shall also have the capability of broadcasting RS-232 commands when the teacher presses the up/down volume controls on their microphone

n. Power Requirements: 24Vdc, Power Supplied from the amplifier.

o. Operating Frequency – 1.9 GHz Band

p. Receiver Type: DECT

q. Mounting Bracket as required

- (1) The receiver shall be capable of being mounted on the ceiling or a wall
- (2) Bracket shall provide mounting to standard electrical boxes Controls: System shall have available the following controls
- (3) Channel 1 Volume Control – Fully controllable from the teacher microphone remotely through the DECT system
- (4) Channel 2 Volume Control – Fully controllable from the teacher microphone remotely through the DECT system
- (5) Auxiliary Input Volume Control – Fully controllable from the teacher microphone remotely through the DECT system
- (6) Alert Controls on Teacher Microphone – Two (2) buttons on the sides of the microphone
- (7) Recording Control on Teacher Microphone – One (1) button on the front of the microphone

N. Teacher Body Pack Transmitter Audio Enhancement STD-14

1. Provide a body pack transmitter with performance as follows:

- a. Operating frequency – 1.9 GHz - DECT
- b. Audio distortion: <1.0% (± 40 kHz deviation @ 1kHz)
- c. Integrated microphone
- d. Internal charger circuit

- e. Micro USB Charging Port – shall be capable of being charged from a standard USB port – including a port on a computer
 - f. Power button functionality
 - g. Power on – turns the microphone on when microphone is off and button is pressed
 - h. Mute – mutes the microphone when pressed and released once microphone is turned on
 - i. Power Off – push and hold to turn power off
- 2. Additional Function (F) Button Features
 - a. SAFE Alert Functionality – Provides security alert when the two (2) buttons on the sides of the microphone are pressed and held for more than two (2) seconds
 - b. Recording Functionality – Provides simple logic signal when the REC button is pressed on the face of the microphone which activates terminals on the receiver
- 3. External Inputs
 - a. Provide an inputs for an external microphone
 - b. Provide an input for a stereo auxiliary input (Mixed to Mono in microphone)
- 4. Microphone Element – The teacher microphone shall utilize a 10mm microphone element to insure optimum frequency response and maximum pickup of teacher's voice.
- 5. Power 1 - LiON Long Life Battery (Systems using two (2) batteries will not be considered)
 - a. Battery style shall be common between handheld microphone and teacher transmitter. Systems that use different batteries in the handheld vs teacher microphone shall not be considered.
- 6. Provide remote volume control for the system from the teacher's transmitter
 - a. Volume control via the wireless microphone system to allow the teachers to remotely adjust their own volume level.
 - b. Volume control for the other channel from the teacher's microphone
 - c. Volume control for the auxiliary inputs from the teacher's microphone
 - d. Side Alert Buttons – Provide remote control functionality that allows for enabling additional multi-use functions from the teacher microphone.
 - e. REC Button – Provide a button on the face of the microphone that can be used for multiple purposes
- O. Classroom Intercom Call Button WPA-504/502
 - 1. Reference technology floor plans for device locations
 - 2. Single gang decora style call button white in color
 - 3. Black button for intercom call
 - 4. 8P8C (RJ45) connection
 - 5. Matching white decora style face plate
 - 6. WPA-502 includes red emergency button for alerting
- P. Ceiling Enclosure specifications
 - 1. Provide a ceiling enclosure that is sized appropriately for the equipment being installed in each classroom
 - 2. Ceiling enclosure shall be plenum rated and UL Listed
 - 3. Overall dimensions shall be to fit in a standard drop tile ceiling.

4. Enclosure shall support power and data as necessary for equipment.
5. Cover of enclosure shall support mounting of Audio Enhancement XD Receiver, WPA-501 Microphone, and EduCam360 and be lockable.
6. Enclosure should be pre-assembled with equipment by the manufacture

Q. Wall Mount Enclosure

1. Provide a ceiling enclosure that is sized appropriate and specific to house the Audio Enhancement amplifier, Audio Enhancement XD Receiver, AVConnect Receiver and WPA-502/504 Wall Plate. Audio Enhancement receiver shall be seen from the front of the enclosure with accessible buttons.
2. Enclosure shall be wall mountable and support enclosing a single gang 120V electrical outlet.
3. Enclosure shall have a swinging door and a cam or key lock.
4. Enclosure shall be white in color.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. The entire system shall be installed in a workmanlike manner, in accordance with approved manufacturers wiring diagrams and these specifications. The contractor shall furnish all conduits, cable tray, surface raceway, wiring, outlet boxes, junction boxes, cabinets etc... as well as all required miscellaneous materials and labor necessary for the complete installation of the cable support / pathway system.
- B. Wiring may be opened wired in cable tray or "J" hooks above accessible suspended lay-in ceilings. Wiring in walls or exposed on walls shall be enclosed in EMT conduit. Cable shall be supported at a minimum of every 5'.
- C. A nylon pull string shall be installed in each conduit / surface raceway run.
- D. Any locations where flexible metal conduit has to be used, it is to terminate to a junction box on both ends and be securely anchored for proper support.
- E. Conduit indications in the drawings are a minimum standard.
- F. All equipment shall be mounted with sufficient clearance for observation, servicing, testing and accessible from either the floor or ladder. If any device is installed in a location that is deemed inaccessible by the Owner and or Architect / Engineer, it will be moved to an accessible location by the contractor at no additional cost to the Owner.
- G. The contractor shall supply access panels where required and as defined by the Architect / Engineer. Contractor to notify the Architect / Engineer immediately if this issue arises during construction.
- H. All penetration of floor slabs and firewalls shall be fire stopped in accordance with all Federal, State and local codes.
- I. All wiring shall be color coded per National Electrical Code requirements and standards.
- J. All conduit ends shall have plastic grommets to protect cable from damage due to sharp edges on the conduit.
- K. Mounting heights and mounting requirements shall be as shown on the drawings.
- L. All junction boxes shall be clearly marked and labeled for easy identification. Flexible connectors shall be used for all devices mounted in suspended lay-in ceiling panels. All conduits, outlet boxes, junction boxes and panels shall be securely installed and anchored with appropriate fittings and connectors to insure positive grounding throughout the entire system.
- M. No wiring except that of this system shall be installed in this systems cable support / pathway system.

- N. Wiring splices shall be made only in designated junction boxes and tagged on both sides of the junction. The junction shall be made on clearly labeled, insulated terminal strip. Transposing or changing the color-coding of the cable is not permitted. Wire nut connectors are not acceptable. System cable and the 120vac power cable shall be in separate conduits.
- O. It shall be the responsibility of the contractor to wire and connect ancillary devices to this system as listed in this specification section.
- P. Any circuits leaving the building to the outside shall be protected by the appropriate transient protection devices as required by the manufacturer to avoid damage to the system if transient surges are inducted on to these circuits (i.e., lighting strikes).
- Q. Contractor to provide in-wall bracing support for all devices that are to be wall mounted to walls that are not masonry block walls.
- R. All devices shall be protected throughout the entire project. All devices shall be kept free of construction dirt and debris during the entire project. The contractor shall be responsible for replacing at no additional cost to the Owner any devices that are deemed dirty or unsuitable for use by the Owner and or Architect / Engineer throughout the entire project.
- S. All cabling and devices shall be labeled with type written labels. Device labels and cable labels shall match the labeling information that is documented on the as-built drawings. Contractor to coordinate labeling schemes and labeling requirements with A/E prior to commencing with final labeling. Labeling system shall be by Brady or Panduit.

3.2 INSTALLER QUALIFICATION

- A. Installer shall have a BICSI RCDD (Registered Communication Distribution Designer) on staff.
- B. Installer shall have an Avixa CTS (Certified Technology Specialist) on staff.
- C. Installer shall be an Authorized Audio Enhancement reseller and be certified in EPIC System.
- D. Installer shall hold an appropriate State Contracting or Electrical License as required.

3.3 FIELD QUALITY CONTROLL

- A. The system shall be installed and fully tested as listed in these specifications. The system shall be demonstrated to perform all features and functions as listed in these specifications at a minimum.

3.4 TESTING

- A. Reports of any field-testing during the system installation shall be forwarded to the Owner and Architect / Engineer for review and comment.
- B. Each individual system operation on a circuit-by-circuit basis shall be tested for its complete operation. Any devices that are to be connected to the system shall be tested as specified. Device locations and address / circuit numbers are to be documented on the as-built drawings as well as the wiring configuration of the device circuits. Device locations shall be field verified by the contractor and are to include any costs in the bid that is relating to all devices being connected to the system. The procedure for testing the entire system shall be set forth in these specifications and with the consent and approval of the Architect / Engineer, Owner and equipment manufacturer. Confirm testing requirements with the Owner and Architect / Engineer prior to commencing with system testing.
- C. Perform the tests and adjustments necessary to assure the satisfactory quality and level of performance of the system under normal operating conditions.
- D. Establish the normal settings for all controls and devices for all system operational and functional features and record the same for future reference. All levels shall be set and recorded in the as-built documentation for optimum system performance.
- E. The installation technician from the installer / manufacturer shall perform all system tests as

specified. Perform all tests in the presence of the Owner, Architect / Engineer and any designated personnel as deemed necessary by the Owner or Architect / Engineer. This test shall be performed with the devices at their operational location and under normal operational conditions. Bench or default settings for devices are not acceptable. All test and test report costs shall be included in the contractors bid. A checkout report shall be generated by the installation technician and submitted to the Owner and Architect. The report shall include but not be limited to the following:

1. A complete list of all equipment installed with corresponding serial numbers.
2. Indication that all equipment is properly installed, functions and conforms to the specifications.
3. Serial numbers, locations by device and model number for each installed device.
4. Technicians name, specified certification credentials and date of system test.
5. Any additional information as deemed necessary by the Owner and or Architect / Engineer.

F. A substantial completion test shall be performed before the final test and acceptance of the system by the Owner and Architect / Engineer. At the time of the substantial completion system test, provide to the Owner or his representative an oral explanation of the operation and maintenance of the system. Before starting the tests and adjustments listed above, the contractor shall submit the following to the Owner and the Architect / Engineer for review during the substantial completion test:

1. Preliminary as-built wiring diagrams of the entire system.
2. Preliminary copy of the operation and maintenance manuals.
3. Preliminary copy of the system test report form.

G. If no system performance issues arise during the substantial completion test that need to be repaired by the installation contractor, this can be approved as the final system test by the Owner and or Architect / Engineer. If there are performance issues that arise that do need to be repaired, another complete and comprehensive system test will be scheduled and performed to show that the necessary repairs have been properly addressed. These tests will be performed at no cost to the Owner until a time that the system is shown to be in complete operating condition as approved by the Owner and Architect / Engineer.

H. A commissioning report of all the tested functionality of the system shall be provided by a certified L2 technician by the manufacture or by the manufacture themselves.

3.5 DOCUMENTATION AND TRAINING

A. After the final system test and the Owner and Architect / Engineer has accepted the system to be in the proper operating condition, the contractor shall compile and provide to the Owner three (3) complete operation and maintenance manuals and three (3) sets of as-built drawings on the completed system to include but not be limited to the following:

1. Operating and maintenance instruction sheets for each piece of equipment showing the proper operation and maintenance of the system component.
2. Individual factory issued operation and maintenance catalog brochures of all equipment and components that were installed as part of the system. Advertising brochures, submittal data sheets and operational materials are to also be included but shall not be used in lieu of the required technical manuals.
3. Complete as-built wiring diagrams and floor plan drawings of the complete system installation showing how the system was installed. These drawings shall include any devices that are connected to the system with their address / circuit number documented as well as the wiring configuration of all device circuits. The as-built drawings shall be an updated and revised copy of the submittal drawings showing all modifications made during the installation of the system. A copy of the as-built drawings in electronic format on CD/DVD generated in AutoCAD

Release 2014 or higher will be forwarded on to the Owner and Architect / Engineer for archiving in the operation and maintenance manuals.

4. A statement of guarantee including the date of the termination of the warranty as well as the phone number of the person to be called in the event of equipment failure.
 5. A cover letter, for the above mentioned tests, certifying the entire system and its components, application and installation meets or exceeds the recommendations of the manufacturer, all applicable code requirements and test specifications.
- B. The final and installed version of the system software shall be provided to the Owner on a CD/DVD for storage in the operation and maintenance manuals. These manuals shall be used for final check out of the system.

END OF SECTION 26 0773

SECTION 26 08 51
HEATING TERMINALS**PART 1 – GENERAL****1.1 DESCRIPTION OF WORK**

- A. Extent of heating terminal work is indicated by drawings, schedules and specifications.
- B. Types of electrical heating terminals in this section include the following:
 - 1. Self-regulating cable
 - 2. Constant wattage cable
 - 3. Monitoring controller and sensor
- C. The heating terminal work shall be designed and installed to provide freeze protection for all exterior and interior piping including, but not limited to, supply, return, fill, drain and equalizing lines on chillers and cooling towers, fire protection systems where indicated or subjected to freezing and rain water conductors where indicated.

1.2 SUBMITTALS

- A. Product Data: Submit manufacturer's data on heating terminals, including dimensions, capacities, ratings, performance characteristics, gauges and finishes of materials, installation and wiring instructions.
- B. Shop Drawings: Submit assembly type shop drawings showing unit dimensions, construction details, and field electrical connection details.

PART 2 – PRODUCTS**2.1 ELECTRIC HEAT TRACING CABLE**

- A. The heat tracing cable shall be either self-regulating or constant wattage type. Cable installation shall be designed to maintain 40 deg. F in a -20 deg. F ambient temperature with a 25 MPH wind factor and a 20% safety factor. System shall be designed to operate at the voltage indicated on the plans.
- B. Heat loss design shall be calculated on a nominal 1-1/2" fiberglass insulation thickness. Pipe sizes and lengths shall be taken from the Mechanical, Plumbing and Fire Protection drawings.
- C. Heat trace system shall be complete with, but shall not be limited to, controller, sensors, trace cable, wiring, connectors, junction boxes, mounting brackets, supports and fastenings as required in the quantities and lengths to suit the required installations.
- D. Monitoring Controller: Furnish a microprocessor base controller with the following characteristics:
 - 1. Supply Voltage: 120/277 Vac, +/- 10%, 50/60 Hz, internal power less than five watts.
 - 2. Environmental Temp.: -40°F to 125°F maximum operating temperature range; 0% - 95% R.H. @ 40°C non-condensing
 - 3. Microprocessor: Non-volatile memory; no data loss on power outage.
 - 4. Load Current: 30 AMPs maximum
 - 5. Control: Double pole solid state switching
 - 6. Temp. Sensor Input: 100 ohm platinum RTD, 3 wire, 20 ohm maximum, lead wire compensation, $\alpha = .00385$ ohms/ohm/deg. C.
 - 7. Outputs: Unit alarm output configurable as "open on alarm" or "close on alarm". AC alarm triac: isolated solid-state triac, SPST, 0.5 AMP max. @ 12 to 277 volts AC.
 - 8. Indicators: LED: Program Mode, Actual Temperature, Control Temperature, Heater Current, Power ON, Heater ON, Alarm Conditions/Programming

Parameters. Digital Display: Actual Temperature, Control Temperature, Heater Current, Programming Parameter Values, Alarm Values.

9. Setpoints:

Temperature:

Units: Deg. F or Deg. C
Control Range: -40 deg. F to 999 deg. F or OFF
Low – temp. alarm: -40 deg. F to 999 deg. F or OFF
High – temp. alarm: -40 deg. F to 999 deg. F or OFF

Ground Fault:

Alarm Range: 20 to 100 mA
Trip Range: 20 to 100 mA or OFF

Current:

Low Alarm Range: 0.0 to 30.0 AMPs or OFF
High Alarm Range: 1.0 to 30.0 AMPs or OFF
Power Limit: 1.0 to 30.0 AMPs or OFF

Auto Cycle Time: 0.5 to 24.0 hours or OFF

10. Alarm Conditions

Low Temperature	Low Current	Memory Failure
High Temperature	High Current	Ground Fault Trip
Ground Fault	Sensor failure	SCR Failure

11. Heat Trace System Diagnostic Test. System cycles heating cable regularly (settable period from 0.5 to 24.0 hours) and confirms proper system operation.

12. Stored parameters (measured): Minimum process temperature, maximum process temperature, maximum ground-fault current, maximum heating cable current.

13. Enclosure: NEMA 4X.

14. Additional Features: Soft start, On/Off or proportional control, power limiting, password protection.

15. Manufacturer: Controller shall be similar to Raychem Corporation's Digitrace 910/920 or approved equal.

E. Heat Trace Sensor: Furnish a 3-wire, platinum resistance temperature detector (RTD) with the following parameters:

- 1) Type: 100 ohm platinum.
- 2) Accuracy: 100 ohm +/- 0.25 ohm @ 0 deg. C.
- 3) Alpha: 0.00385 ohm/ohm/deg. C.
- 4) Temperature Measurement Range: RTD – 300: 300 deg. F. (150 deg. C.)
- 5) Exposure Temperature Limits: RTD – 300: 300 deg. F. (150 deg. C.)

- 6) Manufacturer: Sensor shall be similar to Raychem Corporation's RTD – 300 or approved equal.
 - F. Communications: RS-485 interface to be provided for MODBYS Communications to BAS System.
 - G. Power Wiring: Provide required circuit breakers and wiring to local panel for required quantity of heat trace circuits.
- 2.2 MANUFACTURERS
- A. Subject to compliance with requirements, furnish a heat trace cable system of one of the following:
 - 1. Raychem Corporation
 - 2. Delta – Therm Corporation
 - 3. Thermon Manufacturing Company
 - 4. Approved substitute

PART 3 – EXECUTION

3.1 INSTALLATION OF HEATING TERMINALS

- A. Install heat trace cable system and controls as required, in accordance with equipment manufacturer's written instructions, and with recognized industry practices, to ensure that the heat trace system equipment fulfills project requirements. Comply with applicable installation requirements of the NEC and NECA's "Standard of Installation".
- B. Install electric heat trace cable system after the piping tests are complete and before the piping insulation is applied. The Electrical Contractor shall consult, cooperate and coordinate with both the Mechanical Contractor and the Insulation Contractor in completing the required work.
- C. Install heat trace labels every 15'.
- D. Megger test before and after insulation is complete. Tests to be documented. Tests to be witnessed by the Construction Manager and Insulation Contractor.

3.2 GROUNDING

- A. Provide equipment grounding connections, sufficiently tight to assure a permanent and effective ground, for heating terminals and controls as indicated in contract documents.

3.3 TESTING

- A. Upon completion of installation of heating terminals and controls and after building circuitry has been energized; test heating terminals and all control functions to demonstrate capability and compliance with requirements. Where possible, field correct malfunctioning units, then retest to demonstrate compliance.

END OF SECTION

SECTION 26 09 61 PERFORMANCE LIGHTING SYSTEMS

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This section includes furnishing the following equipment for installation as described under Section 260963:
 - 1. Relay Panels
 - 2. Panic Control System
 - 3. Emergency Lighting Transfer System
 - 4. Equipment Racks
 - 5. House & Work Lighting Controls
 - 6. Lighting Control Console & Accessories
 - 7. Performance Lighting System Ethernet Network
 - 8. Control Device Faceplates
 - 9. Performance Lighting Outlet Devices
 - 10. Cable Assemblies
 - 11. Spare Parts
- B. Related sections include the following:
 - 1. Performance Lighting Systems Installation
 - 2. Common Work Results for Electrical
 - 3. Interior Lighting Fixtures
 - 4. Performance Lighting Fixtures
 - 5. Orchestra Shells
 - 6. Rigging Systems and Draperies
 - 7. Catwalks & Wire Rope Assemblies
 - 8. Commissioning of Electrical Systems

1.03 FULLY WORKING SYSTEMS

- A. Review Drawings and Specifications that affect work in this Section.
- B. Notify Architect upon indication that work in this Section cannot be completed as specified or scheduled.
- C. Provide additional parts or devices required for functional requirements of control systems at no extra cost to Owner.

1.04 DEFINITIONS

- A. Relay Panel: Cabinet accommodating relay modules, load and line connections, and circuit protection.
- B. Dimmer Rack: Cabinet accommodating dimmer modules, load and line connections, and circuit protection.
- C. Plug-In Module: Modular unit that installs in standardized mounting location within dimmer rack.
- D. Relay Module: Plug-in module containing one-, two-, or three-pole mechanical relays.
- E. Dimmer Module: Plug-in module containing one or more dimmers.
- F. Control Module: Plug-in module containing centralized control electronics for dimmer modules.

- G. Data Communication Protocol: Signal that provides control and feedback communications between devices in control system.
- H. DMX 512: Data communications protocol compliant to USITT DMX-512/1990 specification (ANSI E1.11-2004).
- I. RDM: Data communications protocol compliant to ANSI/PLASA Remote Device Management specification (ANSI/PLASA E1.20 RDM).
- J. ACN: Data communications protocol compliant to ANSI/PLASA Architecture for Control Networks specification (ANSI E1.17-2006 ACN & E1.31 Streaming ACN).
- K. POE / Power Over Ethernet: 802.3AT compliant scheme of powering devices on an Ethernet system.

1.05 QUALITY ASSURANCE AND STANDARDS

- A. References to code, standards, specifications, and recommendations of technical societies, trade organizations, and governmental agencies will refer to the latest edition of such publications adopted and published prior to bid submittal. All codes and standards will be considered a part of this specification as if they were fully included.
- B. Work and materials shall comply with rules and recommendations of:
 - 1. Prevailing national, state, and local building codes.
 - 2. UL, ETL, cUL, CSA and CE Labels – where materials and equipment are available under the continuing inspection and labeling service of applicable independent product testing and certification services, provide such labels, materials, and equipment.
 - 3. National Fire Protection Associate (NFPA) Publication: National Electrical Code, NFPA70 as applicable to installation and construction of performance lighting and control equipment.
 - 4. NEMA Compliance pertaining to components of performance lighting equipment.
 - 5. United States Institute for Theatre Technology, Inc. (USITT) DMX512/1990 (ANSI E1.11-2004).
 - 6. ANSI/PLASA Remote Device Management (ANSI/PLASA E1.20 RDM) and Architecture for Control Networks (ANSI E1.17-2006 ACN & E1.31 Streaming ACN) standards.
 - 7. Institute of Electrical and Electronics Engineers, Inc. (IEEE) 802.3 and 802.11n.

1.06 SUBMITTALS

- A. Bid Submittals
 - 1. Bill of materials: Identify parts by common industry standard numbers and descriptions.
 - 2. Cut Sheets: Manufacturer's catalog datasheets of all products listed in bill of materials.
 - 3. Statement: Manufacturer agrees to warranty provisions.
 - 4. Projected Timetable: List time in weeks for following activities:
 - a. Shop drawing preparation
 - b. Fabrication
 - c. Shipping to site
 - d. System commissioning
 - e. As-built drawing preparation
- B. Shop Drawings
 - 1. Format: PDF files.
 - 2. Shop drawings shall include:
 - a. Pictorial drawings: All major components, sub-assemblies, parts list, dimensions, material and finish notes, quality assurance listings.
 - b. Wiring diagrams: Components and interconnections to other components.
 - c. Bill of materials: Accessories and spare parts not drawn.

- d. Not acceptable: Catalog cut sheets.
- 3. Review: Fabrication shall not commence until Theatre Consultant and Architect determine that the shop drawings are in compliance with design intent of Contract Documents.
- 4. Revisions: Resubmit as required.
- C. Manuals
 - 1. Format: PDF files on USB flash drive.
 - 2. Manuals shall include:
 - a. System description.
 - b. Operation instructions, including safety measures.
 - c. Maintenance instructions, including recommended procedures and schedules for inspecting system components.
 - d. Catalog cut sheets for all purchased equipment.
 - e. Recommended spare parts list.
- D. As-Built Drawings
 - 1. Format: PDF files on USB flash drive.
 - 2. Delivery: Within one month of system acceptance.
 - 3. As-built drawings shall include:
 - a. Drawings of all system components.
 - b. Control schematics and risers.
 - c. Bill of materials.

1.07 PROJECT CONDITIONS

- A. Submit: Written confirmation that related electrical work, as shown on Drawings, provides necessary physical accommodations or installation and operation of equipment.
- B. Delivery: Within three weeks of award of contract.

1.08 WARRANTY

- A. Manufacturer shall warrant equipment as follows:
 - 1. According to guarantee provisions in General Conditions.
 - 2. For two years from acceptance of systems, provide services detailed below:
 - a. Technical and Operational Assistance Hotline: Shall be available during normal working hours, evening, and weekends at no additional cost.
 - b. In-stock Spare Parts: Available for major assemblies within 24 hours of contact.
 - 1) Additional Cost: No charge during duration of warranty for exchanges not caused by misuse.
 - c. Warranty period: Commence upon final acceptance by Owner.

PART 2 – PRODUCTS

2.01 ACCEPTABLE SUPPLIER

- A. The equipment shall be supplied by the following:
 - 1. 4Wall
9525 Berger Rd, Ste G
Columbia, MD 21046
410.424.3322
 - 2. Amberient
11110 Reynolds Rd
Kingsville, MD 21087
877.301.7707
 - 3. Barbizon
6437-G General Green Way

Alexandria, VA 22312
703.750.3900

4. M. Cramer Associates
229 North 12th St
Philadelphia, PA 19107
215.627.1225
5. Parlights
1662 Bowmans Farm Rd
Frederick, MD 21701
301.698.9242
6. Starlite Productions
9 Whittendale Drive
Moorestown, NJ 08057
856.780.8000

- B. Additional companies wishing to bid shall submit the following 10 days before submission of bids, for review and approval by Theatre Consultant:
 1. Firm history.
 2. List of completed installations, comparable in scope to the job described here.
 3. Minimum of 5 representative shop drawing sheets.
 4. If requested, a current certified financial statement showing sufficient financial base for the size of job described here.
- C. Furnishing: Equipment and services shall be provided by one manufacturer.
- D. Experience: Manufacturers shall have been continuously engaged in production of performance lighting and control equipment for at least 20 years.
- E. Emergency Support: Manufacturers shall have a toll-free, 24 hour emergency phone line. Response shall be within 30 minutes of phone call.
- F. Substitutions: Substituted equal products shall not be allowed without prior approval of Architect, Electrical Engineer, Theatre Consultant, or Owner.
- G. New products: Provide latest model of specified products provided latest model retains or exceeds characteristics of products specified herein. Manufacturers shall provide demonstration for Architect, Electrical Engineer, Theatre Consultant, or Owner.
- H. Testing: Test and label all equipment at factory prior to shipment.

2.02 PARTS

- A. All materials and equipment provided shall be new and of high quality.

2.03 GROUNDING

- A. These systems shall be grounded, as shown on Drawings and in accordance with applicable codes and regulations and/or at the advice of the Manufacturer.

2.04 CIRCUIT BREAKERS

- A. Conformity: All applicable codes and standards.
- B. Interrupting capacity: 10,000 amperes SCCR for all primary and secondary circuit breakers unless otherwise specified.
- C. Toggle Guard: Provide for branch circuit breakers in equipment rack component mounting panels, control device faceplates, and outlet device faceplates.

2.05 IDENTIFICATION LABELS

- A. Provide labeling and signage for equipment as described herein and/or noted on the Drawings.
 1. Equipment designations and headings: 1/4" height.

2. Secondary information: 3/16" height.

2.06 RELAY PANELS

A. Acceptable Relay Panels:

1. ETC Sensor IQ
2. Vari-Lite RigSwitch+

B. General

1. Relay panel shall be dead front switch boards complete with all relays, control electronics, circuit breakers, and wiring terminations. No external components shall be required.
2. Mounting: Wall mount, surface or recessed.
3. Electrical operation: 120/208V 3 phase, 4 wire + ground.
4. Feed Size: Accept up to 400A per phase.
5. Listing and label: UL/cUL; UL508, UL67, UL924
6. Provide terminals to accept feed and branch wire sizes shown on Drawings.
7. Fault current protection rating: 65,000 SCCR.
8. Voltage Separation: Provide between high voltage and low voltage compartments.
9. Branch load circuit breakers shall be provided as required for branch load terminations.
 - a. Listing and label: UL/cUL; UL489
 - b. Integral mechanically held air gap relay
 - c. Trip current shall not be affected by ambient temperature
 - d. Rated for tungsten loads having an inrush of no less than 20 times normal current.
 - e. Switching duty application rating: 100%
 - f. Load rating: continuous operation at 100% load
 - g. Rapid load switching: internal solenoid shall switch load when breaker at "on" position.
10. Branch circuit capacity: 48 poles, 15A to 30A one, two, and three-pole circuits as required.
11. Relay bank signage: Permanently attached to equipment with following information:
 - a. Project name
 - b. Manufacturer name, toll-free service phone number, and job reference number
 - c. "Designed by Stages Consultants" statement with phone number and web address
12. Relay panel section signage: Permanently attached to equipment with following information:
 - a. Performance venue name
 - b. Equipment designation
 - c. Feed size and source identification
 - d. Schedule of relay numbers listing use, circuit identification, relay type, and load; load information verified to match final as-built conditions

C. Electronics

1. Control electronics shall be microprocessor based, designed specifically for control of dimming systems.
2. Backlit, graphical LCD display shall access following information:
 - a. Breaker state
 - b. Relay state
 - c. Current draw
 - d. Voltage
 - e. Energy use over time
3. Rack shall accept DMX-512/1990 control signal input and one Category 5 or greater IEEE 802.3 Ethernet protocol control signals.
4. Opto-isolated contacted input shall be provided for panic system control.

5. Control modules shall directly support ANSI E1.31 sACN network protocol. Control modules that do not support these protocols shall not be accepted.
6. Control signal input of each individual dimmer rack shall be fully opto-isolated from control signal input of any other rack, and fully opto-isolated from any control signal output.

2.07 PANIC CONTROL SYSTEM

- A. The panic control system shall instantly bring a programmable selection of dimmers and non-dim relays to full with the push of "Panic" button. Panic state shall be released with the push of "Normal" button.
- B. The system shall always be enabled at every control location, regardless of the state of other control systems and independent of emergency power transfer relays.
- C. Panic stations shall consist of the following:
 1. Each panic control location shall consist of two EAO series 61 momentary pushbutton switches with requisite switching electronics.
 2. Pushbutton momentary switches shall be illuminated, with colored lens engraved with button label.
 3. One button shall be labeled "Normal" with green lens.
 4. One button shall be labeled "Panic" with red lens and, hinged protective cover.

2.08 EMERGENCY LIGHTING TRANSFER SYSTEM

- A. Acceptable Emergency Lighting Systems:
 1. ETC ELTS2
 2. LEX Products PowerGATE
 3. SSRC ELTP
- B. General
 1. Emergency lighting transfer system shall be mounted in NEMA 1 type enclosure with hinged locking door.
 2. Enclosure Material: 14 gauge steel.
 3. Mounting: Wall mount, front.
 4. Maximum Dimensions (enclosure containing no more than 12 poles): 36" high x 24" wide x 9" deep.
 5. Maximum Dimensions (enclosure containing no more than 24 poles): 48" high x 30" wide x 9" deep.
 6. Electrical operation: 120/208V 3 phase, 4 wire + ground.
 7. Feed Size: Accept up to 160A per phase.
 8. Listing and label: UL/cUL
 9. Provide terminals to accept feed and branch wire sizes shown on Drawings.
 10. Fault current protection rating: 65,000 SCCR.
 11. The emergency transfer system shall monitor three phases of the normal feed. Upon loss of power to one or more phases, normal system failure, or activation of the panic condition designated branch circuits shall be transferred from dimming system to second power source.
 12. Transfer poles: Phase and neutral legs of each branch circuit load.
 13. Transfer Switch Unit: Electrically-operated and mechanically-held.
 14. Electrical operator: Single-solenoid mechanism, momentarily energized.
 15. The switch shall be positively locked and unaffected by voltage variations or momentary outages such that constant contact pressure is maintained and temperature rise at contacts is minimized.
 16. The transfer switch shall be rated to withstand the RMS symmetrical short circuit current without welding contacts.

17. Fire alarm interface: Isolated signal input shall automatically transfer loads to available secondary power source when facility fire alarm is activated.
18. Test Switch: Key-operated momentary switch for manual control.
- C. Safety Standards: Comply with ANSI/UL1008, ANSI/NFPA 70, ANSI/NFPA 110.
- D. Signage: Permanently attached to equipment with following information:
 1. Performance venue name
 2. Equipment designation
 3. Feed size and source identification

2.09 EQUIPMENT RACKS

- A. Basis of Design:
 1. Middle Atlantic Products WR series for pull-out frame racks
 2. Middle Atlantic Products DWR series for swing frame racks
- B. General
 1. Equipment rack shall be EIA compliant 19", steel cabinet.
 2. Color: Powder coat black
 3. Rackrail Type: 10-32
 4. Maximum Dimensions: 89" high x 24" wide x 33" deep.
 5. Usable Depth: as required for specified equipment
 6. Blank Filler Plates: Provide in un-used spaces. Internal space behind filler plates shall not be obstructed or used.
 7. Panel Legends and Lines: Engraved and filled with engraver's enamel.
 8. Provide non-combustible brackets, shelves, and other supports for heavy components and internal wiring assemblies and harnesses. Provide interior mounting angles to support work-writing tops and drawers.
 9. Component Wiring: 36" long flexible cable harness to numbered barrier terminal block. Terminal block shall be attached to frames in line with associated panels and shall not interfere with adjacent components or filler panels.
 10. Signage: Permanently attached to equipment with following information:
 - a. Project name
 - b. Performance venue name
 - c. Equipment designation
 - d. Feed size and source identification
 - e. Manufacturer name, toll-free service phone number, and job reference number
 - f. "Designed by Stages Consultants" statement with phone number and web address

2.10 HOUSE & WORK LIGHTING CONTROLS

- A. Acceptable House & Work Lighting Control Systems:
 1. ETC Paradigm
 2. Vari-Lite Vision.net
- B. General
 1. Provide microprocessor based, solid state architectural control processor (ACP) that functions independently and in conjunction with lighting control console.
 2. ACP shall be capable of controlling dimmer racks, relay panels, LED systems, automated lighting fixtures, and other device via DMX and ACN.
 3. ACP functions:
 - a. Station programming
 - b. Macro sequencing
 - c. Electronic lockout
 - d. Room combine
 - e. Astronomical time clock events

- f. Preset recall: 512
- g. Fade time between presets
- h. Rate of fade time modification
- i. Concurrent preset recall
 - 1) Multiple presets controlling the same attribute shall first interact based on priority and second based on latest takes precedence (LTP) or highest takes precedence (HTP) as configured.
 - 2) A preset may be designated as an HTP override and shall cause HTP values to be discarded. It shall be possible to specify that a preset or attribute will persist when overridden.
 - 3) When in use, the lighting control console shall override preset levels on a HTP basis. Where there are multiple external sources then priority and HTP shall be used to perform arbitration.
- j. Record presets from lighting control console or other control sources on lighting system
- 4. Communication protocols:
 - a. DMX-512/1990
 - b. ANSI E1.31 (sACN)
 - c. ANSI E1.17 (ACN)
 - d. EIA-232 serial
 - e. Dry contact closure input and output
 - f. Network Time Protocol
- 5. Control channel capacity: 2,048 parameters
- C. Master Stations
 - 1. Master stations shall consist of backlit LED display
 - a. Minimum viewable display size: 7" WVGA
 - b. Minimum resolution: 800x480
 - c. Bezel: Aluminum
 - d. Touch interface: Capacitive with LED backlight
 - e. Viewing angle: 178° horizontal and vertical
 - f. Finish: Shown on drawings
 - g. Provide metal backbox and mounting frames
 - 2. Connect to control system using category 5e or better wire.
 - 3. Master stations shall provide control of lighting processor presets, sequences, fade times, macros, timeclock events, and interfaced external systems.
 - 4. Master stations shall operate using graphic buttons, faders, and other images on programmable control pages. There shall at least 30 custom control pages available.
 - 5. Graphic controls shall represent the active state of all presets, zones, and devices. Status indication shall be tracked across all stations in real-time, including tracking of fades on graphical fader controls.
 - 6. Stations shall allow programming of multiple-level passcodes, page lockout, and visibility.
 - 7. Control pages shall include:
 - a. House light presets (House Full, House Half, House Preset, House Out, Cleaning); work light presets (Pre-Show, Show, Post-Show, Rehearsal, Work, Off); system wide presets (Blackout, Night)
 - b. Performance lighting presets with snapshot record function
 - c. House light zone faders and House light master fader
 - d. Work light, run light, and non-dim zone control buttons
 - e. Lockout function to disable other stations and remote switches
 - f. Setup display for administrative functions

8. Page layout and interface functionality shall be determined by the Theatre Consultant following approval of shop drawings. Programming services shall be provided by the Manufacturer.

D. Entry Stations

1. Entry stations shall consist of programmable momentary pushbutton switches.
 - a. Pushbuttons: EAO series 61
 - b. Mounting panel: 1/8" (3mm) T-5 aluminum
 - c. Finish: Shown on drawings
 - d. Provide flush or surface backbox
2. Momentary push button switches shall be illuminated, with colored lens as noted on the Drawings.
3. Entry Stations shall provide control of a single channel or presets as required.
4. Electronics shall consist of an interface board connected to the control system using Manufacturer's recommended wire type, network topology, and communication protocols.

E. Keyswitch Stations

1. Keyswitch stations shall consist of programmable momentary switches.
 - a. Key switch: EAO series 51
 - b. Pushbuttons: Manufacturer's standard
 - c. Finish: Shown on drawings
 - d. Provide flush or surface backbox
2. Keyswitch shall unlock tour and cleaning pushbuttons for a period of one hour.
3. Tour pushbutton shall energize a user programmable preset of house light zones.
4. Cleaning pushbutton shall energize a user programmable preset of house and work light zones.
5. Keyswitch Station shall connect to the control system using Manufacturer's recommended wire type, network topology, and communication protocols.

2.11 LIGHTING CONTROL CONSOLE

A. Acceptable Control Console:

1. ETC Element 2
2. ETC Ion XE 20
3. Vari-Lite Neo

B. General

1. Lighting control console shall be a microprocessor-based system specifically designed to provide complete control of performance lighting systems.
 - a. External multi-touch screen capability
 - b. Remote video support
 - c. Lighting network device control
 - 1) Direct control of third party sACN/ACN devices
 - 2) DMX512 / RDM hardware interfaces
 - 3) Support MIDI, SMPTE and RS-232 interfaces
2. User interface shall be fully graphical with command line. Control commands shall be accepted as either command line or direct entry.
3. The main control shall consist of numeric keypad, dedicated control keys, context sensitive soft keys, level control wheel, and pointing device.
4. A blind display mode shall allow viewing and modification of all recordable attributes without affecting live stage levels.
5. A patch display mode shall be used to display and modify system control channels with their associated data.
6. Control and programming features for automated fixtures shall include a standard library of fixture profiles; ability to copy and edit existing profiles and create new profiles; and

patch displays including channel and output addressing, 16-bit fade resolution, color characterization allowing color mixing and storing in hue and saturation or native device values.

7. Control channel data shall be recordable as cues, groups, submasters, palettes, effects, macros, curves, and patch contained in non-volatile electronic memory and stored as show data to internal storage or USB storage device.
 8. Simultaneous playback of recorded cue lists shall be possible on up to 200 faders.
 9. The console shall be capable of being placed in Tracking or Cue Only record mode by the user.
 10. Integrated, integral virtual media server shall allow mappable images and animations to rig array. System shall be capable of 40 maps, 12 layers each.
 11. User definable, interactive magic sheet displays shall allow graphical layout of channels, desk functions, and programming tools in live and blind operating modes. Provide standard symbol library and user-import tool for custom graphics.
 12. A freely available offline editing application shall be provided for creation and modification of show data on a personal computer.
 13. A personal computer running client software application shall be able to connect to a control system via the network and view current show data in a mirrored display environment.
 14. The system shall allow remote control from a wireless handheld remote.
 15. The system shall support configuration and operation of two consoles or a console and a dedicated processor as a main and fully tracking backup.
- C. Provide the following control consoles:
1. Auditorium: ETC Ion XE 20 with 12,288 outputs
 2. Black Box: ETC Element 2 with 6,144 outputs
- D. Provide with each console (2) external 24" multi-touch monitors, keyboard, mouse, and task lights.
- E. Furnish the following accessories for each console:
1. Vinyl dust covers for the consoles and monitors. Dust covers shall cover top, sides, front and rear surfaces of equipment.
 2. Cables for each control console
 - a. 10'-0" power: 1
 - b. 25'-0" power: 1
 - c. 10'-0" Ethernet: 1
 - d. 25'-0" Ethernet: 1
 3. Surge protected power strips for console and accessories: 1
 4. Portable uninterruptible power supply, APC Smart-UPS 750VA: 1
 5. 8 GB capacity USB storage keys: 2

2.12 PERFORMANCE LIGHTING SYSTEM ETHERNET NETWORK

- A. Provide a fully functioning Ethernet system. Systems using proprietary formats or protocols other than TCP/IP shall not be accepted.
- B. Network Components
1. Provide IEEE 802.3at 10/100/1000 L3 switches in quantities and locations shown in the Drawings and described herein.
 - a. Switches shall contain auto-sensing ports supporting 10Base-T, 100Base-T, and 1000Base-T. Switches shall support IEEE 802.3ab Type 1000Base-T standard.
 - b. Switches shall be rack mounted in standard 19" racks.
 - c. Switches shall have UTP ports on the front face for connection to other network devices via standard 19" patch panels.

- d. Switches shall have high mean time between failure (MTBF) value as comparatively analyzed with industry standard 802.3at products.
 - e. Provide ports or media converter modules as required for UTP to Fiber-Optic conversion.
 - f. Provide switches in quantities and configurations having sufficient UTP ports for simultaneous connection of all patch bay ports assigned to performance lighting network devices.
 - g. Acceptable manufacturer shall be Cisco Systems or approved equal.
 2. Provide Category 6a or better patch bays as required for termination of network cabling.
 - a. Patch bays shall be rack mounted in standard 19" racks.
 - b. Provide Category 6a or better patch cords as required for connection between the patch bays, switches, and other network devices.
 - c. Provide rack mounted standard 19" cable management systems for each patch panel.
 - d. Acceptable manufacturer shall be Hubbell or approval equal.
 3. Provide Network Services Gateway in quantities and types as shown on Drawings.
 - a. Gateway shall support the following protocols:
 - 1) Dynamic Host Control Protocol (DHCP) for automatic assignment of IP address
 - 2) Dynamic Name Service (DNS)
 - 3) Simple Network Time Protocol (sNTP) for automatic time assignment and synchronization
 - 4) File Transfer Protocol (FTP) for configuration storage and backup
 - 5) Windows File Sharing (SMB) for configuration and file storage and backup
 - b. Gateway shall support real-time logging and notifications of system errors.
 - 1) Logging shall utilize a standard Syslog database.
 - 2) Notifications shall be provided via email messages.
 - c. Gateway shall support storage of performance lighting system and system device configurations.
 4. Provide DMX Gateways in quantities and types as shown on Drawings.
 - a. Gateways shall be intelligent Ethernet devices providing DMX & RDM data distribution over Ethernet data network. Nodes shall be connected using Category 6a or better wire, and powered via Ethernet connection using Power Over Ethernet (IEEE 802.3af). Ethernet connection receptacle shall be Neutrik Ethercon D-Series CAT5e receptacle.
 - b. Gateways shall directly support ANSI E1.31 (sACN) and ANSI E1.17 (ACN) network protocols. Gateways that do not support these protocols shall not be accepted.
 - c. There shall be as standard DMX512 5-pin XLR connectors on the front panel, or as shown on the drawings. It shall be possible to factory configure the connectors to be male or female to meet project requirements.
 - d. Gateways shall be remotely configured via network system wiring using manufacturer's software, control console interface, or standard Web Browser. Specific DMX channels input or output by Node shall be freely configurable by user. Configuration of Node shall be stored in non-volatile memory.
 - e. Portable nodes shall be provided with appropriate mounting hardware for 1.9" (48mm) O.D. pipe as shown on Drawings.
- 2.13 PERFORMANCE LIGHTING CONTROL DEVICE FACEPLATES
- A. Faceplate: 1/8" (3mm) aluminum component mounting panel.
 - B. Surface back boxes: Supplied by performance lighting manufacturer
 - C. Floor boxes: As shown on drawings
 - D. Color: Powder coat black, or as shown on drawings

- E. Legends: Engraved in component mounting panel and filled with engraver's enamel of contrasting color. Legends in black panels shall be white.
- F. Components: As shown on drawings
- G. DMX receptacles: Neutrik B-Series XLR receptacles.
- H. Ethernet receptacles: Neutrik Ethercon CAT6a receptacles. Provide Neutrik HX-CAT6A parallel press tool for cable terminations.
- I. Low voltage barrier: Install between control and power receptacles
- J. Mounting hardware: Coordinate device mounting requirements as noted on drawings and per field conditions.

2.14 PERFORMANCE LIGHTING OUTLET DEVICES

- A. Faceplate: 1/8" (3mm) aluminum component mounting panel.
- B. Surface Back boxes: Supplied by performance lighting manufacturer
- C. Floor boxes: As shown on drawings
- D. Connector strips: As shown on drawings
- E. Color: Powder coat black, or as shown on drawings
- F. Legends: Engraved in component mounting panel and filled with engraver's enamel of contrasting color. Legends in black panels shall be white.
- G. Components: As shown on drawings
 - 1. Flush receptacles: Individually mounted, readily replaceable, and installed off-center to allow space for circuit identification labels.
 - 2. Pigtail receptacles: Suitable strain relief grips for SOOW cables that engages cable's outer jacket.
 - 3. Pigtail length: 18" (0.5M) or as shown on drawings.
- H. Terminals: Provide numbered screw terminals on barrier terminal blocks for field connections within each device. Devices shall be internally wired by Manufacturer.
- I. Mounting hardware: Coordinate device mounting requirements as noted on drawings and per field conditions.

2.15 SPARE PARTS

- A. Furnish 10% spare parts for all perishable items such as pilot light lamps and fuses.
- B. Furnish 2% spare parts for all low voltage and line voltage connectors, minimum of 2 per type.
- C. Furnish the following additional spare parts:
 - 1. (2) Spare dimmer and relay modules of each type listed in the Drawings
 - 2. (1) Spare dimmer rack control electronics module
 - 3. (1) Manufacturer's Lighting Control Console spare parts package

PART 3 – EXECUTION

3.01 SUPERVISION OF INSTALLATION

- A. Manufacturer shall provide instruction and supervision to the Division 26 Contractor as it pertains to the installation of these systems. Provide the necessary personnel for coordination meetings and site visits as requested by the Division 26 Contractor.

3.02 COMMISSIONING

- A. Manufacturer shall provide the services of a qualified on-site engineering representative who shall perform the following:
 - 1. Supervise and instruct equipment installer in all Manufacturer's requirements and specifications.

2. Prior to system energization, inspect the finished installation and confirm that the installation conforms to manufacturer's requirements and specifications. Supervise correction of any deficiencies and retest deficient items.
3. Manufacturer's engineering representative shall be present during energization of the system.
4. In conjunction with the equipment installer, measure and adjust the full dimmer output voltage at each performance lighting receptacle. Typical voltage shall be uniform at each receptacle regardless of branch wiring length. Specific voltage requirements shall be determined by the Theatre Consultant or Electrical Engineer.
5. Verify operation of all control devices and network wiring.
6. Configure all hardware and software to a "show ready" state, including:
 - a. Network device addressing
 - b. Ethernet switches configured for industry standard control protocols
 - c. Dimmer and relay patch, dimmer curves, dimmer output voltage, control priority and similar variables
 - d. Panic preset and fade time
 - e. House light control zones, presets, sequences, fade times, macros, timeclock events, and interfaced external systems
 - f. Lighting control console patched 1 to 1 for all control channels in system
 - g. Console accessories such as remote video, tracking backup, and hand-held remote configured to operate with main lighting control console
 - h. DMX node/gateway patch, priority, and soft labeling
 - i. Lighting system computer software
- B. Provide to the Architect and Theatre Consultant a written report confirming that the system has been properly installed and successfully energized within fourteen (14) days of energization.

3.03 DEMONSTRATION AND ACCEPTANCE

- A. The Architect and Theatre Consultant (or their representatives) shall witness a full demonstration by the Manufacturer of each feature of each piece of equipment in the system. Comply with the following conditions:
 1. The Manufacturer shall provide all necessary personnel and equipment, including lifts and ladders, to demonstrate fully the system's compliance to the specifications.
 2. Contractor's project representative shall be present during testing as required.
 3. Full and uninterrupted access to all areas shall be provided as necessary for complete testing and demonstration.
 4. All loose equipment provided under this Section shall be on site and available for testing.
 5. All architectural lighting fixtures circuited to the dimming system shall be installed and lamped.
- B. Subject to satisfactory on-site demonstration, the Owner's representative shall accept the equipment on behalf of the Owner.
- C. Should the demonstration prove unsatisfactory, the Theatre Consultant and the Architect shall inform the Manufacturer in writing, and the Manufacturer shall rectify the problems. Problems shall be rectified in the shortest time possible. During this period of remedial work, the Owner shall have beneficial use of the equipment. The Warranty period shall commence upon final acceptance by the Owner.

3.04 TRAINING

- A. Provide a factory field service representative to offer instruction to the owner's staff in the proper operation and maintenance of the systems and software for at least 3 full days at a date and time convenient to the Owner.

END OF SECTION

SECTION 26 09 63
PERFORMANCE LIGHTING SYSTEMS INSTALLATION

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. The work of this Section includes all labor, materials, equipment and services necessary to install the electrical work associated with the Performance Lighting Systems, as described in Section 260961 and shown on the Drawings.
- B. Related sections include the following:
 - 1. Performance Lighting Systems
 - 2. Common Work Results for Electrical
 - 3. Architectural Lighting Fixtures
 - 4. Rigging Systems and Controls

1.03 QUALITY ASSURANCE AND STANDARDS

- A. References to code, standards, specifications and recommendations of technical societies, trade organizations and governmental agencies will refer to the latest edition of such publications adopted and published prior to submittal of the bid. All such codes and standards will be considered a part of this specification as if they were fully included herein.
- B. Work and materials shall comply with the rules and recommendations of:
 - 1. Prevailing national, state and local building codes.
 - 2. UL, ETL, cUL, CSA and CE Labels – where materials and equipment are available under the continuing inspection and labeling service of applicable independent product testing and certification services, provide such labels, materials, and equipment.
 - 3. National Fire Protection Associate (NFPA) Publication: National Electrical Code, NFPA70 as applicable to installation and construction of performance lighting and control equipment.
 - 4. NEMA Compliance pertaining to components of performance lighting equipment.
 - 5. United States Institute for Theatre Technology, Inc. (USITT) DMX512/1990 (ANSI E1.11-2004).
 - 6. ANSI/PLASA Remote Device Management (ANSI/PLASA E1.20 RDM) and Architecture for Control Networks (ANSI E1.17-2006, E1.31) standards.
 - 7. Institute of Electrical and Electronics Engineers, Inc. (IEEE) 802.3af and 802.11n.

1.04 CERTIFICATIONS

- A. The Contractor shall submit (as part of the Owner's Manual) certificates from the manufacturer stating that the installed system is operating properly and complies with the manufacturer's recommendations. This information shall be incorporated in the Owner's Manual, as described in 260961
- B. The Contractor shall submit a certificate that the Ethernet system has been tested and complies with all IEEE 802.3, ISO/IEC 8802-3 and PLASA standards. This information shall be incorporated as an appendix to the Owner's Manual, as described in Theatrical Lighting Controls.

1.05 WARRANTY

- A. In addition to the performance lighting controls manufacturer's warranty, provide warranty of the systems and equipment to be free of faulty workmanship or improper adjustment for a period of one year from the date of Owner's acceptance.
- B. Replace items showing evidence of defective materials or workmanship within thirty days after notification. Make repairs without any cost to the Owner.
- C. Resolve any conditions that might present a serious hazard to human life within 24 hours of notification by Owner.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Materials as specified under Division 26.

PART 3 – EXECUTION

3.01 PROTECTION OF EQUIPMENT

- A. Protect the equipment in this and Related Sections from damage and deterioration during all phases of the work, from the time of manufacture to the acceptance of the completed installation.
- B. The Performance Lighting Systems equipment furnished under Section 260961 will become responsibility of the installer until Owner's final acceptance.

3.02 INSTALLATION

- A. Install Performance Lighting Controls system as located on the drawings. Installation shall be in accordance with manufacturer's written instructions, recognized industry practice, and applicable requirements of the National Electrical Code and UL standards.
- B. All load circuit conductors and data wiring for these systems shall be installed in metallic conduit, metal wireways, surface metal raceways, or other approved cable containment. Use of metal-sheathed or armored cable shall not be accepted without prior approval.
- C. Voltage separation shall be maintained between line voltage, low voltage and data wiring.
- D. All load circuit conductors shall be continuous from the performance equipment electrical room to the outlet devices or architectural fixture.
- E. All dimmer and relay panel load circuits must have individual neutral conductors. Neutral conductors must be routed directly adjacent to the live conductors of each circuit.
- F. All data wiring shall be continuous from termination point to termination point; no splices or inline connectors shall be allowed.
- G. Field terminations in these systems shall be as follows:
 - 1. Main feed wires shall terminate in pressure lugs on buss bars.
 - 2. Branch load wires shall terminate on screw terminals on barrier terminal blocks, circuit breakers and switches.
 - 3. Control wires shall terminate on screw terminals on barrier terminal blocks and switches, or as noted.
 - 4. Ethernet cables shall be installed and tested in compliance with all IEEE 802.3.ISO/IEC 8802-3 and ETSA standards.
- H. Wire nuts and field soldered connections, except where noted, are not acceptable in these systems.
- I. These systems shall be grounded, as shown on drawings and in accordance with applicable codes and regulations and/or at the advice of the Manufacturer.
- J. Network Cabling

1. Performance Lighting System data cabling shown in Drawings to convey design intent only. Final quantities, types, and topologies shall be per the Manufacturer's approved shop drawings.
2. Provide Fiber Optic Cable as required for all runs greater than 90 meters (300') or as specifically shown in the Drawings.
 - a. Confirm all cable routing distances to determine appropriate use of fiber runs.
 - b. Cable shall be 62.5/125µm fiber optic cable as required to support network components.
 - c. Cable shall exceed the IEEE802.3z Gigabit Ethernet Fiber specification for 62.5/125µm fiber.
 - d. Cable shall exceed the TIA/EIA 568B Fiber specification.
3. Provide UTP Cable as required for all runs under 90 meters (300') unless specifically shown as Fiber Optic Cable in the Drawings.
 - a. Copper cabling and connecting hardware shall fully comply with TIA/EIA 568B standards and with the standard installation of Category 5E products.

3.03 COMMISSIONING

- A. Prior to energization of the system, perform the following tests and inspections following the instructions of the equipment Manufacturer's on-site engineering representative. Correct deficiencies and retest deficient items.
 1. Inspect each outlet, faceplate, device and loose equipment for defects, finish failure, corrosion, physical damage, correct labeling, and nameplate.
 2. Perform operational tests on mechanical parts and operable devices according to manufacturer's instructions or routine functional operation.
 3. Check tightness of electrical connections with torque wrench calibrated within the previous six (6) months using Manufacturer's recommended torque values.
 4. Perform continuity testing of each branch load circuit receptacle, determining correct polarity of wiring and correspondence between circuit numbers and labeling. Continuity Test Report shall be available upon request. Any problem(s), i.e. open circuit, short circuit, wrong termination, etc. shall be rectified in a timely manner and re-tested.
 5. Test and certify Ethernet network for compliance with all IEEE 802.3, ISO/IEC 8802-3 and ANSI/PLASA standards. Network Compliance Test Report shall be available upon request. Any problem(s), i.e. cable length exceeding standards, open circuit, short circuit, wrong termination, etc. shall be rectified in a timely manner and re-tested. Submit final test report data and letter of certification for inclusion as an appendix to the Manufacturer's Instruction and Maintenance Manual.
- B. Energization of the system shall only commence following written approval of the Manufacturer, and shall take place in the presence of the Manufacturer's on-site engineering representative.
- C. In conjunction with the Manufacturer's engineering representative, measure and adjust the full dimmer output voltage at each performance lighting receptacle. Typical voltage shall be uniform at each receptacle regardless of branch wiring length. Specific voltage requirements shall be determined by the Theatre Consultant or Electrical Engineer.

3.04 DEMONSTRATION AND ACCEPTANCE

- A. The Architect and its representative shall witness a full demonstration of each feature of each piece of equipment in the system.
 1. Contractor shall provide all necessary personnel and equipment to demonstrate fully the system's compliance to the specifications.
 2. Contractor's project representative shall be present during testing as required.

3. Full and uninterrupted access to all areas shall be provided as necessary for complete testing and demonstration.
 4. All loose equipment provided under this and Related Sections shall be on site and available for testing.
 5. All architectural lighting fixtures circuited to the dimming system shall be installed and lamped.
- B. Subject to the on-site demonstration being satisfactory, the owner's representative shall accept the equipment on behalf of the Owner.
- C. Should the demonstration prove unsatisfactory, the Theatre Consultant and the Architect will inform the Contractor in writing, and the Contractor shall rectify the problems. Problems should be rectified in the shortest time possible. During this period of remedial work, the Owner shall have beneficial use of the equipment. The Warranty period shall commence upon final acceptance by the Owner.

END OF SECTION

SECTION 26 09 73
AUDIO / VIDEO SYSTEMS INSTALLATION

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. The work of this Section includes all labor, materials, equipment and services necessary to install the following electrical work associated with the Audio / Video Systems, as described in Section 274117 and shown on the Drawings:
 - 1. A complete, pull-ready conduit system for installation of Audio / Video Systems wiring and devices, including, but not limited to:
 - a. Conduit and raceways.
 - b. Junction/pull boxes.
 - c. Standard back boxes.
 - d. Rack room terminal cabinets and “pull group” boxes.
 - e. Fittings.
 - f. Drag line (pull line)
 - g. Electrical hardware, etc.
 - 2. Installation of nonstandard back boxes for Audio / Video Systems devices provided under Division 27 (to be concurrent with other electrical work).
 - 3. Electrical power service—including transformers, feeder cable, distribution panels, branch circuit panel-boards, and individual wall receptacles.
 - 4. Audio / Video Systems “sound system” isolated ground AC power network.
 - a. Inter-rack AC power wiring, shall be the responsibility of Division 27. Single-point termination to the racks shall be conducted on-site by Division 26.
- B. Electrical service for the above work is shown on the E-series drawings
- C. The QA-series Contract Drawings provide block diagrams and equipment locations. The final design of the control systems is the responsibility of the respective Contractors, who will supervise the Electrical Contractor’s work.

END OF SECTION

SECTION 26 60 10
RIGGING SYSTEMS ELECTRICAL WORK

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. The work of this Section includes all labor, materials, equipment, and services necessary to complete the Stage Rigging and Draperies installation, as shown on the drawings and specified herein, including, but not limited to, the following:
 - 1. Motorized fire curtain
 - 2. Motorized rigging hoists
 - 3. Motorized speaker hoists
- B. The Contractors for the above work will furnish the control system components. The Electrical Contractor shall install the system components, provide conduit and wire runs between components, and perform all terminations.
- C. Electrical service for the above work is shown on the E-series drawings.
- D. The QR-series Contract Drawings provide block diagrams and equipment locations. The final design of the control systems is the responsibility of the respective Contractors, who will supervise the Electrical Contractor's work.

1.03 PRACTICES AND PROCEDURES

- A. Practices and procedures for the work in this Section shall conform to applicable Sections in this Division.

END OF SECTION

SECTION 27 41 17 AUDIO VIDEO SYSTEMS

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

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

1.02 WORK INCLUDED

- A. The Audio Video Contractor (AVC) shall be responsible for all labor, equipment, material, and procedures required for the supply, fabrication, installation, commissioning, and warranty of the Audio Video System (AV) as specified herein and on the AV Contract Drawings, including design and engineering responsibilities, and submission for review of shop drawings, reports, samples, and mock-ups. Detailed descriptions of these requirements are included in “Part 1 - General” and “Part 3 - Execution”.
- B. Requirements Included:
 - 1. The scope of work of this Section shall include, but not necessarily be limited to, the following systems, equipment, material, arrangements, and procedures as indicated and specified herein for:
 - a. All labor, equipment and materials.
 - b. Supply nonstandard back boxes and floor-boxes for installation by Electrical Contractor except where noted.
 - c. Termination of all AV equipment racks.
 - d. Provide supplemental conduit, junction/pull boxes, fittings, and electrical hardware, as required for connection of Sound equipment to the Sound empty conduit system as supplied by Electrical division.
 - e. All wire, wire pulling, and termination.
 - f. All tools and measuring & testing equipment required for installation.
 - g. Daily and final cleanup.
 - h. Shop drawings, samples and mock ups, as built documentation, and operating manual.
 - i. Testing and adjustment, interim shop inspection, initial test report, final site inspection, final test report, and demonstration and instruction.
 - j. Guarantee and warranties, and maintenance and service contract.
- C. Audio Video System:
 - 1. See detailed description of the following system and specific information about the equipment, components, and material in “Part 2 Products”:
 - a. Audio Video System: Permanent Audio Video System, including speech and music reinforcement, archival audio & video recording, music, effects, and prerecorded tracks processing and playback and stage monitor/foldback, utilizing the following subsystems:
 - b. Permanent loudspeaker positions, including rigging points, and cable management.
 - c. AV equipment racks, including appropriate cabinetry.
 - d. Sound mixers, amplifiers, microphones, RF Systems, and digital processing
 - e. Projectors and Projector rigging.
 - f. Communications systems, back of house paging, 70v systems.
 - g. Control and network systems

D. Related Requirements:

1. The following systems, equipment, material, arrangements, and procedures are not included in the scope of work of this Section. Coordinate all work of this Section with the work specified in other sections (exceptions as noted):
 - a. A complete, pull-ready conduit system for installation of Audio Video System wiring and devices—including all conduit and raceway, junction/pull boxes, standard back boxes, terminal cabinets and “pull group” boxes, fittings, drag line (pull line), electrical hardware, etc. (Electrical Contractor).
 - b. Electrical power service—including transformers, feeder cable, distribution panels, branch circuit panelboards, and individual wall receptacles (Electrical Contractor).
 - c. Audio Video System “Audio Video System” isolated ground AC power network (Electrical Contractor). Note: inter-rack AC power wiring, shall be the responsibility of the SC. Single-point termination to the racks shall be conducted on-site by the EC.
 - d. Loudspeaker suspension points
 - e. Equipment rack room (including lighting, furnishings, and finishes) (various Trades).
 - f. Painting and finishing (except as noted below for Audio Video System equipment).
 - g. House telephone, data, life safety, fire alarm, and security systems (Electrical Contractor).

E. Definitions

1. In addition to the definitions in the General Conditions, the following also apply to this Section:
 - a. The term “Consultant” refers to Stages Consultants.
 - b. The terms “Audio Video System Contractor”, “this Contractor”, “AVC” as used in this specification refer to that contractor directly responsible for supply and installation of the Audio Video System.
 - c. The terms “engineer” and “engineering” as used in this specification refers to the interpretation, organization, and execution of the design of the Audio Video System as provided in the Contract Documents.
 - d. The term “supply” as used in this specification indicates that the Audio Video System Contractor shall supply, free issue, including instruction and supervision for installation by others, such equipment, components, and material of the Audio Video System so as to fulfill the intent of the Contract Documents.
 - e. The term “provide” as used in this specification indicates that the Audio Video System Contractor shall supply, fabricate, install, and make operable such equipment, components, and material of the Audio Video System so as to fulfill the intent of the Contract Documents.
 - f. The terms “preapproved equivalent” and “or as approved” as used in this specification indicate that acceptance shall be obtained from the Consultant. Refer to “Product Substitution” below.
 - g. The terms “NIC” or “not in contract” as used in this specification indicate an item or system that shall be furnished under another contract. Preparation for the future inclusion of such an item or system shall be limited to the extent outlined in the Contract Documents.
 - h. The terms “OEM” or “original equipment manufacturer” or “manufacturer” as used in this specification refer to a direct supplier to the Audio Video System Contractor.
 - i. “UON” denotes “unless otherwise noted.”
 - j. “AFF” denotes “above finished floor.”
 - k. “U” denotes “rack unit,” as in “10U” to denote 10 standard 44mm (1.75”) rack units, for a total of 440mm (17.5”) of rack space.

1.03 AUDIO / VIDEO SYSTEM CONTRACTOR

A. Pre-qualified Contractors:

1. AVI-SPL
540 Huntmar Park Dr, Suite B
Herndon, VA 20170
703.796.9011
2. Brandywine Electronics
611 Carson Dr
Bear, DE 19701
302.324.9992
3. Sound Associates, Inc
979 Saw Mill River Road
Yonkers, NY 10710
914.963.3453
4. Sound Com Systems
9918 Windisch Road
West Chester, OH 45069
513.860.4160

B. Audio / Video System Contractor Qualification:

1. Contractors wishing to qualify for this project shall submit the following information:
 - a. Indicate the names of primary stock holders (in excess of 33-1/3%) and individuals, partnerships, or corporations with which the firm is currently affiliated in joint ventures.
 - b. List the principal officers, design and service engineers, and project managers. Provide an organizational structure flow chart.
 - c. Provide descriptions of Three (3) projects of comparable size, scope and nature for which the candidate has provided full services within the last five (5) years. These services should include: project management, system engineering, shop drawings, custom fabrication, installation, commissioning, training, and maintenance. For each project indicate the specifics of the scope of engineering, fabrication, and installation. Include name, address, and phone number of the owner, architect, Audio / Video System consultant, and the person(s) directly responsible for the operation and maintenance of the equipment in each facility.
 - d. List all current projects and their approximate contract value. Include name, address, and phone number of the owner, owner's representative, Audio / Video System consultant, and architect. For each project name the individual(s) who supervised the project management, system engineering, preparation of shop drawings, fabrication of components, installation of equipment, acceptance testing, and commissioning and training.

C. Contractor Submittal

1. All contractors shall submit two (2) copies of the following lists, schedules, and bills of material, including the names of manufacturers, manufacturers' model numbers, quantities, and prices:
 - a. Complete pricing information including base price, add-alternates, and unit prices.
 - b. A complete and accurate list of all of the equipment, components, and material specified in the Contract Documents.
 - c. A schedule of wire and cable as specified in the Contract Documents.
 - d. A list of requests for approval of equivalent equipment, components, material, or systems, per the requirements listed in "Product Substitution" below.
 - e. A list of test equipment to be used in system testing and adjustment, per the requirements listed in "Part 3 Execution: Testing and Adjustment."

- f. A list and description of any equipment or material required for completion of this Section that is not included in the Contract Documents and is not shown on the Architectural or Electrical Contract Documents as being specified by other sections.
- g. A list and description of any changes required to the installation of the empty conduit system, including but not limited to relocation or resizing or reduced or additional conduit, for Audio / Video System equipment provided by the Electrical Contractor.
- h. A separate cost amount, per year, for a maintenance and service contract for a period of five (5) years. Include a complete description of services to be furnished and a schedule of planned maintenance visits. When the Audio / Video System Contract is awarded, the Contractor shall be obligated to furnish the services described, for the fees quoted, should the Owner elect to purchase this separate contract prior to the end of the Guarantee and Warranty period. Refer to "Maintenance and Service Contract" below.
- i. In the event that additional conduit is required to fulfill the intent of the Audio / Video System, the contractor shall include any additional wire.
- j. Any financial or scheduling implications for additional work specified in other sections, as recommended by a contractor, shall be assessed prior to award of this Section.

D. Consultant Review

- 1. The Consultant shall refer to the lists, schedules, and bills of material outlined above in order to determine fulfillment of the requirements of the Contract Documents. These lists, schedules, and bills of material are included for the purpose of evaluation. The acceptance these submissions shall not be understood to relieve the Contractor of the responsibility of meeting any and all requirements of the Contract Documents.

E. Product Substitution

- 1. If an original equipment manufacturer or other supplier has permanently stopped fabrication of a specified item or has replaced an item with an almost identical item that has a new model number, the Contractor shall state this or, if there is sufficient time for amendment of the Contract Documents, notify the Consultant.
- 2. Contractors are advised that requests for approval of equivalent equipment, components, and material of other OEMs or suppliers are permitted. Such products shall be evaluated on the basis of equivalent quality and performance. The Consultant shall be the sole judge of performance equivalency and shall give written approval, by addendum, of all product substitutions. Provide sufficient catalog data, specifications, technical information, and samples to permit a complete evaluation by the Consultant.
- 3. While the equipment, material, arrangements, and procedures described in the Contract Documents indicate specific details for realization of the Audio / Video System, contractors may propose alternate products and details that shall fulfill the functional parameters of the outlined system. In such event, contractors shall submit a complete set of alternate Contract Documents not less detailed than these and following the same general format. Also submit a detailed statement indicating, paragraph by paragraph, where the equipment, material, arrangements, and procedures that shall be offered differ from those specified in the original Contract Documents.
- 4. Any changes to the original Contract Documents shall be evaluated and given written approval by the Consultant.

F. Responsibilities

- 1. Provide complete and working Audio / Video System as outlined in the Contract Documents.
- 2. Carry out work in accordance with best trade practices, and engineer, fabricate, provide and install all items in accordance with the Contract Documents, the manufacturers'

recommendations and in compliance with applicable codes, and consult with other trades performing adjoining work in order to provide an installation of first class quality.

G. Extent

1. Provide all labor, equipment, material, and procedures required, listed, scheduled, mentioned, or implied in the Contract Documents to engineer, fabricate, install, and commission the Audio / Video System.
2. Provide also all labor, equipment, material, and any necessary incidental items not specifically called for in the Contract Documents but required for a complete and satisfactory installation of the Audio / Video System.
3. Ensure that all equipment, components, and material specified or otherwise required to complete the installation are compatible with each other and with the conditions of expected use. Any errors, omissions or ambiguities in the Contract Documents are not to condition these requirements but shall be brought to the attention of the General Contractor and Consultant for evaluation of any possible effect on the intent of the Contract Documents. Submit all notifications in writing to the General Contractor and Consultant. Lack of such notification shall be understood to indicate acceptance of all requirements of the Contract Documents, and any future claims shall be rejected.

H. Coordination

1. Refer to the Project Electrical Drawings, to determine Audio / Video System device quantities and general locations. Refer to Project Architectural drawings for exact device locations.
2. Be familiar with the requirements of the Electrical Contract to ensure the coordination of the work in this Section with the work of the Electrical Contractor.
3. Provide the Electrical Contractor with drawings, diagrams, and other information in order to ensure proper coordination of the AC power system and Audio / Video System empty conduit installations. This work shall be part of this Contractor's early coordination effort and shall be provided in a timely manner according to a schedule of the project established by the General Contractor.
4. Coordinate work of this Section with the work of other trades so that all installations are executed in such a manner as to ensure proper system performance. Provide appropriate mounting of equipment and components and avoid conflicts in positioning of the various installations of other contractors and trades.
5. References to the General Contractor or other trades shall in no way modify the responsibility of this Contractor to provide a coordinated, complete, and working installation of all work required by the Contract Documents.
6. All drawings, schedules, RFIs, and other communication shall be coordinated with and submitted through the General Contractor.

I. Means and Methods

1. The Audio / Video System Contractor is solely responsible for the means and methods of all manufacturing and installation techniques, sequences and procedures of construction, and shall be responsible for coordination of these items with and through the General Contractor and the Consultant.

J. Sub-Contractors

1. Use of Sub-Contractors by the Audio / Video System Contractor shall in no way modify its responsibility.

K. Suppliers

1. Use of a product from a particular original equipment manufacturer, whether specified in the Contract Documents or substituted by the Audio / Video System Contractor, shall in no way modify its responsibility. Refer also to General Conditions.

L. Site Dimensions and Conditions

1. The Audio / Video System Contractor is solely responsible for the correctness of dimensions and quantities, shall verify site conditions, and obtain site dimensions and quantities required for proper installation of the work included in this Section; and shall be responsible for coordination of these with and through the General Contractor. The Audio / Video System Contractor shall take dimensions on site for all equipment and material that shall be provided (including custom fabricated components) and be entirely responsible for their accuracy.
2. Examine the work of other trades at the site to ensure that all aspects of the related work are in the proper condition to receive the work included in this Section.
3. Obtain through the General Contractor, where necessary, copies of relevant base building Contract Documents, including shop drawings, to ascertain existing field conditions not open to view (e.g., wall or ceiling construction).
4. In particular, verify all necessary field conditions including, but not limited to: the size, routing, and location of all conduit and raceway, pull/junction boxes, cast in-place back boxes, and accommodation of non-standard backboxes. Also verify size and configuration of the Equipment Rack Room. Such information is critical to the production of accurate shop drawings.
5. Provide any additional drawings, information, or templates where work by other trades must be modified for the proper installation and operation of the work included in this Section.
6. Do not begin manufacture of any custom fabricated equipment or components until satisfied that the devices, as designed, shall fit in the space available.
7. Provide all additional items required for the completion of the Sound empty conduit system, as supplied by the Electrical Contractor, including but not necessarily limited to conduit hardware, back boxes, and wire to accommodate site conditions, and in order to complete the interpretation of the Contract Documents with no change in the contract price. Any changes to equipment details and/or mounting details shall be reviewed and approved by the General Contractor and Consultant prior to shop fabrication or field installation.

M. Design and Engineering

1. The requirements outlined in the Contract Documents establish basic design parameters including means of operation, control, dimensions, and visual appearance. The Audio / Video System Contractor's design responsibilities shall include:
2. Interpreting the Contract Documents so as to accomplish the purposes described.
3. Carrying out the execution of the work.
4. Executing modifications and additions to the details as may be required to fulfill the intent of the Contract Documents.
5. Maintaining the design/control/operation concepts as described in the Contract Documents.
6. The Contract Documents describe performance attributes of the systems that shall be provided under this Section and, as such, are not Professionally Engineered documents. This Contractor is responsible for the engineering of systems described in the Contract Documents.

N. Painting and Touch Up

1. The Audio / Video System Contractor shall be responsible for painting all Audio / Video System equipment and components exposed to view and shall also be responsible for the correction of minor cosmetic damage so that all Audio / Video System equipment and components are in clean and unblemished condition at the time of the final site inspection by the Owner and Consultant.

2. Any non-cosmetic damage shall be promptly repaired or replaced by this Contractor, prior to the final site inspection and without cost to the Owner.
- O. Cleanup
 1. Leave work areas clean and in proper order at the end of each work day. Coordinate with Owner's performance and rehearsal schedule, as required. Daily and final cleanup shall be to the satisfaction of the General Contractor and/or the Owner.
- P. Omissions And/Or Errors
 1. Omissions and/or errors within the Contract Documents shall not relieve this Contractor of the responsibility for providing a properly functioning installation of the Audio / Video System as outlined in "Part 2 - Products: System Description."
- Q. Permits
 1. Obtain all permits and pay all fees necessary for the execution of the work included in this Section.
- R. Safety and Code Requirements
 1. The Audio / Video System equipment, material, arrangements, and procedures shall conform to the applicable local building, electrical and safety codes and all other applicable code requirements, with industry standards of operation and practice, and applicable safety requirements. The completed installation shall allow the users to work and operate the Audio / Video System in a safe environment.
 2. Regulations, codes of practice, and other reference documents cited in the Contract Documents shall apply to the work of this Section with the same authority as if included word for word in this specification.
 3. Where provisions of the Contract Documents supplement those of cited reference documents, the more stringent provisions shall apply. Refer also to General Conditions.

1.04 SUBMITTALS

A. Project Timetable:

1. Submit a Audio / Video System project timetable for approval, after consultation with the General Contractor and the Consultant.
2. This timetable shall outline scheduling and dates for all project milestones including design and engineering, shop drawing submittal and review, sample and mock-up submittal and approval, shop fabrication, interim shop inspection, site installation, testing and adjustment, initial test report submittal and approval, final site inspection, programming, final test report submittal and approval, operating manual and as-built documentation submittal and approval, demonstration and instruction, and project completion.

B. Pre-Submittal Meeting:

1. The Audio / Video System Contractor shall meet with the General Contractor and the Consultant after the project timetable has been submitted and prior to beginning work on shop drawings. The project manager and chief project designer for the Audio / Video System Contractor must attend and be prepared to review the timetable, and to discuss the concepts described in the Contract Documents and proposed methods of execution of those concepts.

C. Shop Drawings:

1. Submit, through the General Contractor, shop drawings for submittal to the Consultant. Shop drawings shall include all information necessary to fully explain design features,

- engineering details, appearance, function, fabrication, mounting, installation, and interconnection of all equipment. This submittal shall include the following:
- a. Block diagrams (indicating all equipment interconnection and wiring).
 - b. Schematic diagrams of custom circuitry and equipment.
 - c. Equipment rack layouts.
 - d. Custom receptacle plate, combination panel, and communication control pendant layouts (full scale drawings required).
 - e. Custom mounting brackets.
 - f. Mounting conditions and methods for all devices.
 - g. Wiring distribution diagrams and wire pulling schedules.
 - h. Detail drawings as required.
2. Submit names of the original equipment manufacturers or other suppliers, the specific model numbers of all Audio / Video System components, appropriate OEM catalog sheets, and technical data sheets. Submit also detailed descriptions of any required modifications to the specified equipment.
 3. Submit a complete, itemized list of all equipment and material that shall be provided as part of the Audio / Video System. All equipment and material shall be listed by the same name, and in the same order as it appears in "Part 2 - Products." Submit also similar lists for the portable equipment, spare parts, and test equipment to be supplied.
 4. Shop drawings shall represent actual fabrication and installation details. Information on all shop drawings shall be designed, engineered, and drafted by this Contractor. Direct reproductions of contract drawings are not acceptable as shop drawings and shall be rejected.
 5. Provide shop drawings separated into the various systems, where each set of drawings contains that information necessary to describe each system completely. The shop drawing submittal shall also include a fully referenced table of contents.
 6. Consultant Review:
 - a. The shop drawings shall be reviewed by the Consultant and shall be approved before the Audio / Video System Contractor begins fabrication and installation of any aspect of the Audio / Video System. Note that the review of shop drawings by the Consultant is to determine conformance with the design concept and with information included in the Contract Documents. Only those shop drawings returned to this Contractor with a satisfactory review status shall be used in the execution of this Section. Non-conformities and errors detected during the shop drawing review shall be noted on the drawings and returned to the Audio / Video System Contractor upon completion of the review. The Contractor is responsible for the completeness and accuracy of the shop drawings.
 - b. Shop drawings or packages of shop drawings that are incomplete shall be marked "rejected" until such time as the complete set of relevant drawings is submitted. It is impossible for the Consultant to adequately review technical equipment submissions unless all details have been adequately represented.
 - c. Approval of those shop drawings that include any non-conformities or errors that are not detected during the Consultant's review shall not relieve this Contractor of the sole responsibility to provide an installation adhering strictly to the requirements of the Contract Documents.
 - d. Shop drawing review does not include engineering calculations by the Consultant unless expressly indicated on the drawings.
 - D. Custom Software Programming including Graphical Interface. Provide for approval at least 6 weeks prior to system commissioning electronic copies of all custom software. It is the

Contractor's responsibility for all custom software programming for the audio systems.
Coordination with the Consultant is required for the development of the software.

- E. Wireless Frequency analysis. It is the responsibility of the contractor to coordinate all wireless frequencies. The contractor shall perform a spectral sweep from 140 MHz through 3 GHz in the facility and then present a written report of proposed new frequencies. The Sound Contractor must arrange and perform this sweep at a time of day that reflects the time of performances. The contractor should also include in the report additional frequencies for future expansion. The Contractor will incorporate any existing and other new frequencies in the determination of the new frequencies to be used, including but not limited to wireless intercom, wireless cameras and wireless radios.
- F. Samples And Mock-Ups:
 1. After review of appropriate shop drawings, submit one (1) sample each of the following items, clearly labeled with manufacturer name, model number, and other pertinent data, for approval by the Consultant:
 2. All cloth and/or metal grille material, with integral framing or support construction where appropriate.
 3. Custom paint samples for Audio / Video System devices requiring a change in color from that supplied by the manufacturer. Each sample shall be applied to a 150mm x 150mm (6" x 6") piece of material closely matching the surface characteristics of each device type to be painted. On the back of each sample indicate the painting system, type of paint for each coat (including primer), the color and sheen of the finish coat, and description of the item(s) and location(s) where the color on the paint sample will be used.
- G. Record Drawings:
 1. Keep a complete set of white prints of the specification and all contract drawings for this Section of the work, as well as shop and installation drawings. Any changes made during installation should be carefully noted and transferred to the appropriate documents to show "as-installed" work in accordance with Section 1, Submittals.
 2. At the time of the initial test report submission, submit one (1) corrected set of record drawings and shop/installation drawings for review by the Consultant.
 3. Late changes or adjustments performed as corrections to punch list items or as change orders after practical completion of the contract, shall be reflected on updated record drawings by this Contractor.
 4. After review by the Consultant, make any required revisions to the record drawings until the contents are satisfactory to the Consultant.
- H. Operating Manual:
 1. Provide one (1) copy of operating manuals in accordance with Section 1, Submittals. Mark each section with tabular dividers using permanent labels protected by plastic. All drawings (B-size and larger) shall be folded into individual vinyl pockets (sheet protectors). Include the following items:
 - a. Title sheet labeled "Audio / Video System—Operating Manual", project name, and date.
 - b. Table of contents.
 - c. Names, addresses, and phone numbers of Audio / Video System Contractor, sub-Contractors, and suppliers.
 - d. Final version of the equipment list.
 - e. System description.
 - f. Operating instructions.
 - g. Periodic maintenance procedures.
 - h. List of all spare parts and equipment.

- i. Complete OEM data sheets, operating manuals, service manuals, and related documentation.
 - j. Block and schematic diagrams of all systems.
 - k. Plugging key plan, showing wiring and receptacles (i.e., a quick-reference chart of combination panels, wall receptacles, and patching only).
 - l. Device, wiring, termination, and hardware schedules.
 - m. List of equipment design parameters including safe working capacities, maximum simultaneous operations, and similar information.
 - n. Maintenance instructions for finished surfaces and material.
 - o. Record of performance (Final Test Report data) as demonstrated at final site inspection sessions.
 2. Prepare one (1) draft copy of the Operating Manual for review by the Consultant four (4) weeks prior to the final site inspection. The document shall be clearly marked "FOR REVIEW." After review by the Consultant, make any required revisions to the Operating Manual until the contents are satisfactory to the Consultant.
- I. Mounted Block Diagram:
1. Provide prints of each Audio / Video System block diagram in the equipment rack room. Mount each diagram in a poster frame and securely mount in each control/rack room adjacent to the equipment racks. Block diagrams shall be of approved record drawings.
- 1.05 COMMISSIONING
- A. Testing and Adjustment:
1. Perform tests and adjustments to the Audio / Video System at the project milestones indicated below, and as specifically outlined in "Part 3 - Execution: Testing and Adjustment."
- B. Interim Shop Inspection:
1. Test and demonstrate the functions of all systems, equipment, assemblies, and subassemblies of the Audio / Video System in the shop or factory no later than Six (6) weeks prior to project completion. Provide all test equipment, and perform all tests and demonstrations in the presence of the Consultant. The systems, equipment, and components that shall be tested and demonstrated include, but are not necessarily limited to, the following:
 - a. Audio / Video System equipment, including playback computers, signal processing racks, amplification and loudspeakers.
 - b. Notify the Consultant at least three (3) weeks prior to the date when all systems, equipment, assemblies, and subassemblies are complete and ready for testing. The equipment shall be made available to the Consultant for a period of at least one (1) week for testing and inspection prior to shipment. Do not ship any piece of equipment without either written verification of successful shop testing, or waiver of shop testing from the Consultant.
 - c. Prepare a draft of the initial test report (outlined below), indicating all pre-installation or shop testing, and submit the report to the Consultant for review prior to shipment of equipment from this Contractor's shop.
- C. Initial Test Report:
1. Perform all testing outlined in this specification. This shall occur after substantial performance of the Audio / Video System, and before scheduling the final site inspection.
 2. Submit a complete report on the results of all testing and adjustments for review by the Consultant, and also certify, in writing, that the work of this Section is complete, operational in every respect, and that the Audio / Video System are ready for the final site inspection.
- D. Final Site Inspection:

1. Upon approval of the initial test report, the Audio / Video System Contractor shall notify the General Contractor and Consultant, in writing, and schedule the final site inspection for a time no later than four (4) weeks prior to the scheduled substantial completion of the project. During this inspection demonstrate all the tests described in this specification, and be prepared to demonstrate the operation of any or all portions of the Audio / Video System, as requested by the Consultant.
 2. Furnish sufficient technicians to operate all equipment and to perform such tests and adjustments as may be required by the Consultant during this inspection. Provide also sufficient engineering and field service personnel to aid the Owner and Consultant, and to direct the technicians in testing, adjusting, and explaining the systems. Ensure that ladders and other means are provided to allow access to all devices to be tested. Ensure that no other work is scheduled in the audience chamber or stage areas during the time of this inspection. All temporary bracing, scaffolding, etc., shall be removed to permit full operation of, and access to, all equipment.
 3. Should the work inspected not be substantially performed at the time of first inspection, this Contractor shall compensate the Owner for any consulting and transportation costs incurred by the Owner and Consultant during all inspections.
 4. If the system does not fulfill each and every aspect of the Contract Documents, make all necessary adjustments or other required changes in order to bring the installation into conformance with the Contract Documents at no additional cost to the Owner.
- E. Installed System Measurement, Verification and Optimization:
1. Upon completion of the Final Test procedure, proceed with the comprehensive complex measurement of the electroacoustic performance of the various components of the performance-related sound equipment. This testing procedure includes all of the signal path leading up to and through the loudspeaker systems and their processors. This contractor shall provide a SMAART measurement system and will have subcontracted a Consultant-approved SMAART operator who will conduct the actual measurements and supervise the optimization of these systems. This measurement process shall be scheduled for a period of two (2) consecutive days. Ensure that no other work is scheduled in the ride area during the time of this procedure. All temporary bracing, scaffolding, etc., shall be removed to permit full operation of, and access to, all equipment.
 2. Furnish sufficient technicians to help operate all Audio / Video System equipment and to perform the various corrective tasks that are revealed during this procedure, including rigging adjustments and polarity correction. Provide all required support equipment such as computer monitors, keyboards, two-way radios, etc. Ensure that ladders and other means are provided to allow access to all devices to be tested.
- F. Programming:
1. Following completion of System Optimization, the Consultant and Project creative team will undertake a two-week Ride programming period. Contractor shall provide full technical personnel support during this process.
- G. Final Test Report:
1. After completion of the final site inspection and system optimization, submit a final version of the complete report on all testing and adjustment outlined in this specification for review by the Consultant. The final test report shall be accompanied by a letter certifying that the Audio / Video System conform to the Contract Documents, that the installation is complete in all details, that the final site inspection is complete and successful, that the system optimization is complete in all details and that the system ready to be turned over to the Owner. Include printouts of SIM II measurement plots showing pre and post optimization.
- H. Demonstration And Instruction:

1. Instruct the Owner and/or the facility's operating personnel in the operation and care of the systems during two (2) separate sessions for not less than a total of eight (8) hours. This instruction shall include:
 2. Operating procedures for proper use of all systems.
 3. Proper maintenance of all systems.
 4. Replacement procedures for user replaceable parts.
 5. The first demonstration and instruction session shall occur directly after acceptance of the final test report. The second session shall occur at a time arranged by the Owner and/or the facility's operating personnel, and shall be no sooner than the next day and no later than one (1) month afterwards. The precise timing of these sessions shall be determined by the Owner, at the Owner's convenience. The sessions shall be videotaped by this Contractor on portable video equipment. A dvd of the recorded session shall be submitted to the Owner within one (1) week following the taping.
 6. As a portion of this instruction, present the final, approved, version of the Operating Manual to the Owner, General Contractor and Consultant for preview at least two (2) weeks prior to the first instruction session. Review the contents of the Operating Manual with the Owner and/or the facility's operating personnel as part of the first session.
- I. Guarantee And Warranties:
 1. Furnish the Owner with a written guarantee in accordance with General Conditions, covering all engineering, equipment, material, and installation workmanship incorporated into the work of this Section, until one (1) year after date of substantial completion of the project.
 2. Service Calls
 - a. All guarantee and warranty work shall be carried out at no additional cost to the Owner for any labor, parts, shipping or transportation. Warranty replacement equipment shall be provided within 24 hours of official notice by the Owner.
 3. Equipment Warranties
 - a. Warranty of replacement equipment and components shall be the same as for the original devices, and shall begin on the date of installation of the replacement item. Replace spare parts used during the warranty period at no additional cost. Note all such replacement equipment and components in a written report to the Owner and the Consultant, and in an addendum to the Operating Manual.
 - b. In the absence of a maintenance and service contract (outlined below), honor all extended warranties offered by original equipment manufacturers beyond the one (1) year guarantee outlined above. The Audio / Video System Contractor shall not be responsible for any labor, transportation, shipping, or miscellaneous costs not covered by the OEM incurred during service calls to repair or replace extended warranty equipment.
 4. Follow-Up Testing and Adjustment
 - a. Provide technicians to test and adjust the Audio / Video System, at a mutually agreed upon time, approximately six (6) months after substantial completion of the project. This follow-up visit shall include any needed testing and repair of all items covered under the guarantee, and testing and readjustment of all items identified in the maintenance procedures. Provide a written report to the Owner and Consultant outlining the extent and results of the follow-up testing and adjustment.
 5. Repeated Failures
 - a. If a particular component, part, or piece of equipment fails more than three times during the warranty period, the failure shall be deemed to be due to engineering and/or installation error. In this event take action within 24 hours of official notice by the Owner to modify or correct the defect by replacement of faulty equipment and/or changes to engineering concepts or installation methods.

J. Maintenance and Service Contract:

1. In addition to providing guarantee and warranty service, make available to the Owner a separate service contract to begin after expiration of the guarantee and warranties outlined above. The service contract shall be at the Owner's cost, renewable yearly, and available for the life of the Audio / Video System. This service contract may be provided directly by this Contractor or through an approved local or regional service center.
2. The service contract shall cover every item provided and supplied under this section of the contract. Service offered shall include, but not necessarily be limited to, repair of components, temporary equipment, replacement of parts, and a regular maintenance program for all equipment in the Audio / Video System. The service contract shall specify a guaranteed response time.

PART 2 – PRODUCTS

2.01 THEATER AND CAFETERIA

	description	mfr	model	qty
A Permanent Loudspeaker/dDSP/Amplifier - Theater				
1	Loudspeaker - Center	d&b audiotechnik	ALi90 Z0733.001	1
2	Loudspeaker - Left & Right	d&b audiotechnik	E12-D Z0602.001	2
3	Loudspeaker - Subwoofer	d&b audiotechnik	Vi-SUB Z0538.001	1
4	Loudspeaker - Underbalc	d&b audiotechnik	5S Z1616.000	5
5	Loudspeaker - Small Monitor	d&b audiotechnik	E6 Z0350.001	6
6	AL V-SUB Adaptor	d&b audiotechnik	Z5461.000	1
7	Vi Mounting Frame	d&b audiotechnik	Z5387.000	1
8	Flying Adaptor for E-12D	d&b audiotechnik	Z5354.000	2
9	Wall Mount S for 5S	d&b audiotechnik	Z5422.000	5
10	Horizontal Yoke for E6	d&b audiotechnik	Z5378.000	4
11	C-Clamp w/ 3/8" thread	The Light Source	MAB3/8	9
12	4-Channel Power Amplifier/DSP - 25D	d&b audiotechnik	Z2810.500	1
13	4-Channel Power Amplifier/DSP - 5D	d&b audiotechnik	Z2880.500	2
14	Custom #12 NL2 Cables for Permanent Loudspeakers	Whirlwind	\$500 Allowance	1
15	Miscellaneous Rigging Materials incl Safeties for all Loudspeakers	Custom	\$500 Allowance	1
B Mixing System				
1	Digital Mixing Console System, 48 channel/32 faders	Allen & Heath	AH-SQ-7	1
2	SQ-7 Dust Cover	Allen & Heath	AH-AP11334	1
3	SQ-7 Tablet Bracket	Allen & Heath	AH-SQ-BRACKET	1
4	64x64 Dante Expansion Card	Allen & Heath	AH-SQ-SDANTE64-A	1
5	16in x 8out Dante Audio Expander	Allen & Heath	AH-DT168	2

6	Rack Mount kit for Dante Audio Expander	Allen & Heath	AH-AB-168-RK19	2
7	12out Output Audio Expander	Allen & Heath	AH-DX012	1
8	Portable 16in x 8out Dante Audio Expander	Allen & Heath	AH-DT168	1
9	iPad Air, 64GB, Wifi, w/ Smart Folio	Apple	iPad Air 64GB wifi	1
C Wireless Microphones - Booth Rack System				
1	UHF Digital 2 Ch Wireless Combo Mic System Recvr/Handheld/HH TX/MMD 835 Dyn Mic/Bodypack Tx/ME2 Lav Mic - Confirm Frequency Bands	Sennheiser	EW-DX MKE 2/ 835-S SET	1
2	Active Antenna Splitter for 8 Receivers, Incl PSU	Sennheiser	EW-D ASA(Q-R-S)	1
3	EW-D AB Antenna Booster 470-550 MHz	Sennheiser	EW-D AB(Q)	2
4	EW-D AB Antenna Booster 520-608 MHz	Sennheiser	EW-D AB(R)	2
5	Passive, Directional Antenna	Sennheiser	ADP-UHF	2
6	EW-D Charging set, Incl 70N charger, 2 BA70 batteries	Sennheiser	EW-DX CHARGING SET	1
7	Miscellaneous Rigging Materials for Antenna Mounting	Sennheiser	\$200 Allowance	1
D Wired Microphones and Direct Boxes				
1	Handheld, dynamic Microphone	Shure	SM-58LC	4
2	Handheld, dynamic Microphone w/switch	Shure	SM-58S	1
3	Dynamic Instrument Microphone	Shure	SM-57LC	2
4	Condenser Instrument Microphone, cardioid	Shure	SM-81LC	4
5	Condenser Recording Microphone, cardioid, Matched Pair	Neumann	KM 184-MT-STEREOSET	2
6	Drum Microphone Kit	Shure	DMK57-52	1
7	Miniature Omni Instrument Kit, incl XLR adapter	DPA	4099-DC-101-U	2
8	Direct Box, Jensen, single-ch	Radial	JDI	2
9	Direct Box, Jensen, PC/iPod	Radial	JPC	1

10	Instrument Cable, 10'	Whirlwind	SN10	2
11	iPod Cable, 3.5mm Stereo>2x M-XLR, 6'	Whirlwind	MST2XM06US	2
E Microphone Stands				
1	Microphone Stand, Round Base, Black	K&M	260/1	4
2	Microphone Stand, One-hand clutch, stackable, Black	K&M	26075	6
3	Microphone Stand, Tripod w/ Boom, Black	K&M	210/8	4
4	Microphone Stand, Short, Round Base, w/ Boom, Black	K&M	25960	2
5	Microphone Boom Arm	K&M	211/1	1
6	Microphone Clamp	K&M	238	4
7	Microphone Holder	K&M	240/5	4
8	Microphone Desk Stand, Black	Atlas	DS7E	6
9	Microphone Stand Crate	Custom	\$500 Allowance	1
F Microphone Cable				
1	Microphone Cable, Canare/Neutrik, 10'	Whirlwind	MK410NP	5
2	Microphone Cable, Canare/Neutrik, 25'	Whirlwind	MK425NP	15
3	Microphone Cable, Canare/Neutrik, 50'	Whirlwind	MK450NP	10
G Speaker Cable				
1	Speaker Cable - NL4 25'	Whirlwind	NL4-025	4
2	Speaker Cable - NL4 50'	Whirlwind	NL4-050	4
3	Speaker Cable - NL4 Coupler	Whirlwind	NL4MMX	2
H Wireless Intercom				
1	1.9GHz Wireless Intercom System, 8 Users incl. Headsets	Hollyland	Solidcom C1 Pro	1

I Program Audio and AV Control System				
1	Q-SYS Core Processor w/24 local IO channels	QSC	Core 24f	1
2	Q-SYS 10" PoE Touch Screen Controller	QSC	TSC-101-G3	3
3	4U Rack Panel w/ 2Gang cutout	Whirlwind	Custom	1
4	Stage Manager Page Station - PoE, 2-Gang	QSC	Zip4	1
5	PTT Paging Microphone - Mag Base	QSC	Zip4-PTT-Mag	1
6	Desktop enclosure for Page Station	Ace Backstage	147G2BK	1
7	House Microphone	Shure	VP89	2
8	Microphone Mounting Hardware, Allowance	Custom	\$100 Allowance	1
9	Ceiling Loudspeaker, 70v Transformer (use Amp Channels from Cafeteria Amplifier	Sonance	PS-C63RT	6
10	Pendant Ceiling, 70v Transformer for Scene Shop	Sonance	PS-P63T	4
11	Volume control, 70V, 50W	Lowell	LVC50-SS	1
12	Volume control - Multi Input, 70V, 50W	Lowell	CS650-SS	1
J Assistive Listening System				
1	FM Assistive Listening System, w/transmitter, 4 receivers, 12-unit Charging Tray	Listen	LS-71-072	1
2	Receiver, digital	Listen	LR-5200-072	26
3	Ear Buds	Listen	LA-161	26
4	Ear Phone/Neck Loop Lanyard	Listen	LA-430	4
5	12-Unit Charging Tray	Listen	LA-381-01	2
K WUXGA Front Projection System and Screen - Theater				
1	20,000 Lumen WUXGA LCD Projector	Panasonic	PT-MZ20KL	1
2	2.10-4.41:1 Zoom Lens	Panasonic	ET-EMT750	1

3	Large Venue Projector Mount	Chief	VCT	1
4	Large Venue Vibration Iso Coupler	Chief	CMA348	1
5	Truss Ceiling Adaptor	Chief	CMA365	1
6	Hardware to mount to Balcony Rail	Custom	\$300 Allowance	1
7	16:10 Fixed Flown Projection Screen: 424.5" Diag.	Draper	383512	1
8	Rigging Supplies for Screen Attchment to Lineset Batten	Custom	\$500 Allowance	1
9	Wall Plate HDMI Encoder w/ Bluetooth	Visionary	DuetE5-WP-BT- Black	2
10	Projector HDMI Decoder	Visionary	D5200	1
L UHD Camera and Distribution System				
1	4K 6GSDI Compact Camera for FOH	Marshall	CV380-CS	1
2	Hardware mount to Balcony Rail	Custom	\$200 Allowance	1
3	4K 12G SDI Router (Shared With BlackBox)	Blackmagic	Smart Videohub 20X20	1
4	4K TV, 43", Dressing Rooms	Sony	FZ-43BZ35J	2
5	43" TV Display Mount	Chief	TS325TU	2
6	4K TV, 55", Stage Left and Stage Right, Scene Shop	Sony	FZ-55BZ35J	3
7	55" TV Display Mount	Chief	TS325TU	3
8	4K TV, 65" Orch Pit	Sony	FZ-65BZ35J	6
9	65" RV Display Mount	Chief	TS525TU	6
10	12G SDI-HDMI Converter w/PSU	Blackmagic	Micro 12G-SDI- HDMI	7
11	HDMI Cables for TVs, 3'	Kramer	C-HM/HM/ETH-3	7
M 2 PTZ Camera Streaming System				
1	4K PTZ Camera, 1/1.8" CMOS, 3G SDI. 30x Lens	PTZOptics	Move4K 30X	1

2	4K PTZ Camera Wall Mount	PTZOptics	PT-WM-3-xx	1
4	PTZ Controller	PTZOptics	PT-JOY-G4	1
5	SDI Switcher with Webcam Interfacer	Blackmagic	ATEM SDI PRO ISO	1
6	17" LCD 3G SDI Monitor	Feelworld	P173-9HSD	1
N Equipment Rack, Portable Storage Cabinet				
1	Equipment Rack- AV ER1 Booth Rack	Middle Atlantic	BGR-4532-AV	1
2	Equipment Rack- AV ER2 Amplifier Rack	Middle Atlantic	BGR-3827-AV	1
3	Cable Lacer Bars 2" Offset - 10pk	Middle Atlantic	LBP-1.5R90	2
4	1sp Brush Panel	Middle Atlantic	BR1	2
5	1sp Rack Vent Panel	Middle Atlantic	VT1	2
6	1sp Blank Panel	Middle Atlantic	EB1	3
7	2sp Blank Panel	Middle Atlantic	EB2	0
8	3sp Rack Drawer	Middle Atlantic	D3	0
9	2sp Rack Vent Panel	Middle Atlantic	VT2	2
10	1sp Rack Shelf 10" deep	Middle Atlantic	U1V	1
11	Rack Panel Screws	Middle Atlantic	HP500	1
12	Rack Mount Horizontal Power Distribution	Middle Atlantic	PDX-920R	2
13	Internal Work Light	Middle Atlantic	LT-GN-WL	2
14	6-Step Power Sequencer	Middle Atlantic	MPR-SEQA	1
15	Modular Power Raceway 32"	Middle Atlantic	MPR-3A	1
16	Modular Power Raceway 56"	Middle Atlantic	MPR-6A	1
17	8" MPR 20A Double Duplex Iso Module	Middle Atlantic	M-2X20IGA	3
18	8" MPR Blank Panel	Middle Atlantic	MPR-BL8A	2
19	8" MPR 20A Iso Module - Sequenced Outlet	Middle Atlantic	RLM-20IGA	3
20	Rackmount Switch for Sequencier	Middle Atlantic	S-DEC	1
21	1U panel w/ Decora Cutout for Switch	Middle Atlantic	DEC P 1X1	1
22	TechFlex, 1.25"-2.75" expandable tubing	TechFlex	PET8-50-BK	2

23	Cable Management, in rack, vertical cable tray	Hellerman, equal	2x2, 3x3	2
O Networking				
1	Network Router/Wifi Access Point	Netgear	SXR80	1
2	24 Port L3 Network Switch M4250 series(Booth)	Netgear	GSM4230P	2
3	24 Port L3 Network Switch M4250 Series (Amp)	Netgear	GSM4230P	2
4	12 Port L3 Network Switch M4250 Series (Dante)	Netgear	GSM4212P	2
P Custom Panels, Patch Cables				
1	Custom Panel, laser-etched, black aluminum	WW Custom	C11, C12, C13, C14, C15, C31	6
2	Custom Panel, laser-etched, black aluminum	WW Custom	C16, C17, C18, C19	4
3	Custom Panel, laser-etched, black aluminum	WW Custom	DV Panels	8
4	Custom Panel, laser-etched, black aluminum	WW Custom	PRJ Panel	2
5	Custom Panel, laser-etched, black aluminum	WW Custom	CAM Panel	3
6	Custom Panel, laser-etched, black aluminum	WW Custom	A2 Panel	1
7	Custom Panel, laser-etched, black aluminum	WW Custom	ANT Panel	5
8	Custom Panel, laser-etched, black aluminum	WW Custom	S1 Panel	5
9	Custom Panel, laser-etched, black aluminum	WW Custom	S2 Panel	3
10	Custom Panels, Patch Panels	WW Custom	XLR Tie Lines-4U	2
11	Custom Panels, Patch Panels	WW Custom	XLR Tie Lines-1U	1

12	Custom Panels, Patch Panels	WW Custom	Loudspeaker Patch Panel	1
13	Custom Panels, Patch Panels	WW Custom	RF Antenna Panel	1
14	Custom Panels, Patch Panels	WW Custom	SDI Tie Lines	1
15	12G HD-SDI Patch Panel	Canare	161U-BJRK	1
16	24 Port CAT6A Shielded Patch Panel	Leviton	4S255-H24	3
17	Patch Cable - 3' NL2	Sescom	NSP2-003	6
18	Patch Cable - 3' XLR	Whirlwind	MK403NP	16
19	Patch Cable - 2' XLR	Whirlwind	MK402NP	16
20	Patch Cable - 3' 12G SDI BNC	Laird	12GS DI-B-B-003	6
21	Small Wall Box for HDMI Wall Plate	FSR	WB-X1-GNG	2
22	Flush Mount Cover for Small Wall Box-White	FSR	WB-X1-CVR-WHT	1
23	Surface Mount Cover for Small Wall Box-Black	FSR	WB-X1-SMCVR-BLK	1
Q Cafeteria Projection				
1	16,500 Lumen WUXGA LCD Projector	Panasonic	PT-MZ17KLBU7	1
2	2.10-4.14:1 Zoom Lens	Panasonic	ET-EMT750	1
3	Access V Recessed Electric Projection Screen: 120" x 192" 16:10	Draper	140043	1
4	Low Voltage Control Module for Screen	Draper	LVC-IV p/n:121233	1
5	3-Button Control Station for Screen	Draper	LVC-S p/n:121225	1
6	Projector Scissor Lift - SL-6	Draper	SL-6 p/n:300271	1
7	Scissor Lift Closure Panel - Type B	Draper	300289	1
8	Wall Plate HDMI Encoder w/ Bluetooth	Visionary	DuetE5-WP-BT-Black	1
9	Projector HDMI Decoder	Visionary	D5200	1
10	Rack HDMI Encoder - For Theater Camera Feed	Visionary	E5200	1

R Cafeteria Audio & Control				
1	UHF Digital 2 Ch Wireless Combo Mic System Recvr/Handheld/HH TX/MMD 835 Dyn Mic/Bodypack Tx/ME2 Lav Mic - Confirm Frequency Bands	Sennheiser	EW-DX MKE 2/835-S SET	1
2	Passive, Directional Antenna	Sennheiser	ADP-UHF	2
3	EW-D Charging set, Incl 70N charger, 2 BA70 batteries	Sennheiser	EW-DX CHARGING SET	1
4	Q-SYS 10" PoE Touch Screen Controller	QSC	TSC-101-G3	3
5	Flush-Mount Locking Cover for Touch Screen	FSR	WB-TSC-FM-10	1
6	High-Output Pendant Speaker, 70v	Sonance	PS-P85T	12
7	8 Ch/250watt Network Amplifier, 70v	QSC	MPA-Q 8x250	1
S Wire & Cable				
1	A1 - Microphone cable, 1pr - 1000'	Belden	9451	1
2	A2 - Microphone cable, 2pr - 1000'	Belden	1509C	0.3
3	A4 - Microphone cable, 4pr - 1000'	Belden	1510C	2
4	D1 - 75 Ohm 12G-SDI Coaxial Cable - 1000'	Belden	4794R	3
5	D2 - 50ohm RG-8/U Coaxial Cable - 1 Foot	Belden	9913	400
6	D3 - 4x23 AWG Twisted Pair, CAT6A, Foil Shield - 1000'	West Penn	4246AF	13
7	D4 - 4x20 AWG Stranded Copper w/ PVC Jacket - 1000'	West Penn	242	1
8	F1 - 2x 12 AWG Stranded Copper w/ PVC Jacket - 1000'	Belden	5000UP	4
9	G1 - 2x 14 AWG Stranded Copper w/ PVC Jacket - 1000'	West Penn	226	0.5
10	LOT, Pre-made Cables for all Interconnect	Custom	\$1,000 Allowance	1
11	LOT, Pre-made Cables for all Patching	Custom	\$500 Allowance	1
12	Misc Wiring and Rigging Hardware	Custom	TBD	1

2.02 BLACKBOX

	description	mfr	model	qty
A Permanent Loudspeaker/dDSP/Amplifier - BlackBox				
1	Loudspeaker - Center	d&b audiotechnik	U3 Z1005.000	1
2	Loudspeaker - Left & Right	d&b audiotechnik	U7 Z1015.000	2
3	Loudspeaker - Subwoofer	d&b audiotechnik	Bi10 Z2021.000	1
4	Loudspeaker - Mix Fill	d&b audiotechnik	U3 Z1005.000	1
5	Loudspeaker - Small Monitor/ Effects	d&b audiotechnik	5S Z1616.000	7
6	U3 Horizontal bracket	d&b audiotechnik	Z5802.000	2
7	U7 Horizontal Bracket	d&b audiotechnik	Z5808.000	2
8	Bi10 Horizontal Bracket	d&b audiotechnik	Z5816.000	1
9	Wall Mount S for 5S	d&b audiotechnik	Z5422.000	5
10	C-Clamp w/ 3/8" thread	The Light Source	MAB3/8	12
11	4-Channel Power Amplifier/DSP - 5D	d&b audiotechnik	Z2880.500	3
12	Custom #12 NL2 Cables for Permanent Loudspeakers	Whirlwind	\$500 Allowance	1
13	Miscellaneous Rigging Materials incl Safeties for all Loudspeakers	Custom	\$500 Allowance	1
B Mixing System				
1	Digital Mixing Console System, 48 channel/17 faders	Allen & Heath	AH-SQ-5	1
2	SQ-5 Dust Cover	Allen & Heath	AH-AP11332	1
3	SQ-7 Tablet Bracket	Allen & Heath	AH-SQ-BRACKET	1
4	64x64 Dante Expansion Card	Allen & Heath	AH-SQ-SDANTE64-A	1
5	12out Output Audio Expander	Allen & Heath	AH-DX012	1
6	16in x 8out Dante Audio Expander	Allen & Heath	AH-DT168	1
7	Rack Mount kit for Dante Audio Expander	Allen & Heath	AH-AB-168-RK19	1
8	iPad Air, 64GB, Wifi, w/ Smart Folio	Apple	iPad Air 64GB wifi	1

C Wireless Microphones - Booth Rack System				
1	4 Channel Digital Mic Receiver - Confirm Frequency Band	Sennheiser	EW-DX EM4 DANTE	1
2	EW-DX Bodypack Transmitter 3.5mm jack	Sennheiser	EW-DX SK	4
3	DW-DX Handheld Transmitter w/ Switch	Sennheiser	EW-DX SKM-S	4
4	Microphone Capsule, dynamic, cardioid for SKM	Sennheiser	MMD 935-1 BK	4
5	Omni Lavalier - Confirm Colors	Sennheiser	MKE 2	4
6	Passive, Directional Antenna	Sennheiser	ADP-UHF	2
7	EW-D Charging set, Incl 70N charger, 2 BA70 batteries	Sennheiser	EW-DX CHARGING SET	2
8	Miscellaneous Rigging Materials for Antenna Mounting	Sennheiser	\$200 Allowance	1
D Wired Microphones and Direct Boxes				
1	Handheld, dynamic Microphone	Shure	SM-58LC	2
2	Handheld, dynamic Microphone w/switch	Shure	SM-58S	1
3	Dynamic Instrument Microphone	Shure	SM-57LC	2
4	Condenser Instrument Microphone, cardioid	Shure	SM-81LC	2
5	Direct Box, Jensen, single-ch	Radial	JDI	2
6	Direct Box, Jensen, PC/iPod	Radial	JPC	1
7	Instrument Cable, 10'	Whirlwind	SN10	2
8	iPod Cable, 3.5mm Stereo>2x M-XLR, 6'	Whirlwind	MST2XM06US	2
E Microphone Stands				
1	Microphone Stand, Round Base, Black	K&M	260/1	2
2	Microphone Stand, One-hand clutch, stackable, Black	K&M	26075	4

3	Microphone Stand, Tripod w/ Boom, Black	K&M	210/8	2
4	Microphone Stand, Short, Round Base, w/ Boom, Black	K&M	25960	2
5	Microphone Boom Arm	K&M	211/1	4
8	Microphone Desk Stand, Black	Atlas	DS7E	2
9	Microphone Stand Crate	Custom	\$500 Allowance	1
F Microphone Cable				
1	Microphone Cable, Canare/Neutrik, 10'	Whirlwind	MK410NP	5
2	Microphone Cable, Canare/Neutrik, 25'	Whirlwind	MK425NP	5
3	Microphone Cable, Canare/Neutrik, 50'	Whirlwind	MK450NP	5
G Program Audio and AV Control System				
1	House Microphone	Shure	VP82	1
2	Microphone Mounting Hardware, Allowance	Custom	\$100 Allowance	1
3	2 Ch/200 Watts 70v amplifier	QSC	MPA-A20V	1
4	Ceiling Loudspeaker, 70v Transformer	Sonance	PS-63RT	2
5	Volume control, 70V, 50W	Lowell	LVC50-SS	1
H Assistive Listening System				
1	FM Assistive Listening System, w/transmitter, 4 receivers, 12-unit Charging Tray	Listen	LS-71-072	1
2	Receiver, digital	Listen	LR-5200-072	2
3	Ear Buds	Listen	LA-161	2
I WUXGA Front Projection System and Screen				
1	8,000 Lumen WUXGA LCD Projector	Panasonic	PT-MZ882	1

2	2.72-4.48:1 Zoom Lens	Panasonic	ET-ELT22	1
3	Large Venue Projector Mount	Chief	VCT	1
4	Large Venue Vibration Iso Coupler	Chief	CMA348	1
5	Hardware to mount to Wire rope grid	Custom	\$300 Allowance	1
6	16:10 Electric Roll-Down Screen Acumen XL 198" Diag	Draper	152103	1
7	Low Voltage kit w/ 3-Position Switch	Draper	121233	1
8	Wall Plate HDMI Extender - HDBaseT	Atlona	AT-OME-EX-TX-WP	1
9	HDBaseT to HDMI Receiver w/Audio	Atlona	AT-OME-RX11	1
J UHD Camera and Distribution System				
1	4K 6GSDI Compact Camera for FOH	Marshall	CV380-CS	1
2	Hardware mount to Balcony Rail	Custom	\$200 Allowance	1
K Equipment Rack, Portable Storage Cabinet				
1	Equipment Rack- AV ER3 Booth Rack	Middle Atlantic	BGR-4532-AV	1
2	Cable Lacer Bars 2" Offset - 10pk	Middle Atlantic	LBP-1.5R90	1
3	1sp Brush Panel	Middle Atlantic	BR1	2
4	1sp Rack Vent Panel	Middle Atlantic	VT1	2
5	1sp Blank Panel	Middle Atlantic	EB1	2
6	Rack Panel Screws	Middle Atlantic	HP500	1
7	Rack Mount Horizontal Power Distribution	Middle Atlantic	PDX-920R	1
8	Internal Work Light	Middle Atlantic	LT-GN-WL	1
9	6-Step Power Sequencer	Middle Atlantic	MPR-SEQA	1
10	Modular Power Raceway 32"	Middle Atlantic	MPR-3A	1
11	8" MPR 20A Double Duplex Iso Module	Middle Atlantic	M-2X20IGA	1
12	8" MPR 20A Iso Module - Sequenced Outlet	Middle Atlantic	RLM-20IGA	2

13	Rackmount Switch for Sequencier	Middle Atlantic	S-DEC	1
14	1U panel w/ Decora Cutout for Switch	Middle Atlantic	DEC P 1X1	1
15	TechFlex, 1.25"-2.75" expandable tubing	TechFlex	PET8-50-BK	2
16	Cable Management, in rack, vertical cable tray	Hellerman, equal	2x2, 3x3	2
L Networking				
1	24 Port L3 Network Switch M4250 series(Booth)	Netgear	GSM4230P	1
2	12 Port L3 Network Switch M4250 Series (Dante)	Netgear	GSM4212P	2
M Custom Panels, Patch Cables				
1	Custom Panel, laser-etched, black aluminum	WW Custom	C21,C22,C23,C24,C25,C26,C27,C28	8
2	Custom Panel, laser-etched, black aluminum	WW Custom	PRJ Panel	1
3	Custom Panel, laser-etched, black aluminum	WW Custom	CAM Panel	1
4	Custom Panel, laser-etched, black aluminum	WW Custom	A2 Panel	1
5	Custom Panel, laser-etched, black aluminum	WW Custom	ANT Panel	3
6	Custom Panel, laser-etched, black aluminum	WW Custom	S1 Panel	1
7	Custom Panel, laser-etched, black aluminum	WW Custom	S2 Panel	4
8	Custom Panels, Patch Panels	WW Custom	XLR Tie Lines-4U	2
9	Custom Panels, Patch Panels	WW Custom	Loudspeaker Patch Panel	2
10	Custom Panels, Patch Panels	WW Custom	SDI Tie Lines	1
11	24 Port CAT6A Shielded Patch Panel	Leviton	4S255-H24	2

N Wire & Cable				
3	A4 - Microphone cable, 4pr - 1000'	Belden	1510C	1
5	D2 - 50ohm RG-8/U Coaxial Cable - 1 Foot	Belden	9913	150
6	D3 - 4x23 AWG Twisted Pair, CAT6A, Foil Shield - 1000'	West Penn	4246AF	4
2	F1 - 2x 12 AWG Stranded Copper w/ PVC Jacket - 1000'	Belden	5000UP	4
10	LOT, Pre-made Cables for all Interconnect	Custom	\$500 Allowance	1
11	LOT, Pre-made Cables for all Patching	Custom	\$250 Allowance	1
12	Misc Wiring and Rigging Hardware	Custom	TBD	1

2.03 PORTABLE RF RACK

	description	mfr	model	qty
A Portable Wireless Microphone Rack				
1	4 Channel Digital Mic Receiver - Confirm Frequency Band	Sennheiser	EW-DX EM4 DANTE	6
2	EW-DX Bodypack Transmitter 3.5mm jack	Sennheiser	EW-DX SK	20
3	DW-DX Handheld Transmitter w/ Switch	Sennheiser	EW-DX SKM-S	4
4	Microphone Capsule, dynamic, cardioid for SKM	Sennheiser	MMD 935-1 BK	4
5	Omni Lavalier - Confirm Colors	Sennheiser	MKE 2	20
6	Active Antenna Splitter for 8 Receivers, Incl PSU	Sennheiser	EW-D ASA(Q-R-S)	1
7	Passive, Directional Antenna	Sennheiser	ADP-UHF	2
8	EW-D Charging set, Incl 70N charger, 2 BA70 batteries	Sennheiser	EW-DX CHARGING SET	12
9	Miscellaneous Rigging Materials for Antenna Mounting	Sennheiser	\$200 Allowance	1
10	10 Port L3 Network Switch M4250 Series (Dante)	Netgear	GSM4210P	2
11	1sp Rack Shelf 10" deep	Middle Atlantic	UIV	1

12	Rack Power Conditioner	Furman	PL-Pro C	1
13	3sp Rack Drawer	Middle Atlantic	D3	2
14	Custom Patch Panel	Whirlwind	RF Rack Patch	1
15	16RU-22" Deep Equipment Rack with Casters	AudioPile	R16-22	1

2.04 GYMNASIUM

	description	mfr	model	qty
A Permanent Loudspeaker/dDSP/Amplifier - Gym				
1	Pendant Loudspeaker - High Output - Center Court	Sonance	PS-P85T	6
2	Pendant Loudspeaker - High Output - N & S Bleachers	Sonance	PS-P85T	4
3	Pendant Loudspeaker - High Output - E & W Bleachers	Sonance	PS-P85T	16
4	8-Channel Power Amplifier/DSP - 25D	QSC	CXQ8K8	1
5	Miscellaneous Rigging Materials incl Safeties for all Loudspeakers	Custom	\$500 Allowance	1
B Wireless Microphones -Gym				
1	4 Channel Digital Mic Receiver - Confirm Frequency Band	Sennheiser	EW-DX EM4 DANTE	1
2	DW-DX Handheld Transmitter w/ Switch	Sennheiser	EW-DX SKM-S	4
3	Microphone Capsule, dynamic, cardioid for SKM	Sennheiser	MMD 935-1 BK	4
4	Passive, Directional Antenna	Sennheiser	ADP-UHF	2
5	EW-D Charging set, Incl 70N charger, 2 BA70 batteries	Sennheiser	EW-DX CHARGING SET	2
6	Miscellaneous Rigging Materials for Antenna Mounting	Sennheiser	\$200 Allowance	1
C Program Audio and AV Control System				
1	Q-SYS Core Processor w/8 Flex IO Channels	QSC	Core 8 Flex	1

2	Q-SYS 10" PoE Touch Screen Controller	QSC	TSC-101-G3	2
3	Flush-Mount Locking Cover for Touch Screen	FSR	WB-TSC-FM-10	1
4	2-IN/2-OUT XLR Dante Panel	QSC	UNDX210+	2
D Assistive Listening System - Confirm quantity for ADA compliance				
1	FM Assistive Listening System, w/transmitter, 4 receivers, 12-unit Charging Tray	Listen	LS-71-072	1
2	Receiver, digital	Listen	LR-5200-072	26
3	Ear Buds	Listen	LA-161	26
4	Ear Phone/Neck Loop Lanyard	Listen	LA-430	4
5	12-Unit Charging Tray	Listen	LA-381-01	2
E WUXGA Front Projection System and Screen - Theater				
1	20,000 Lumen WUXGA LCD Projector	Panasonic	PT-MZ20KL	1
2	.950-1.36:1 Zoom Lens	Panasonic	ET-EMW500	1
3	Large Venue Projector Mount	Chief	VCT	1
4	XXL Projector Guard	Chief	PG4A	1
5	Truss Ceiling Adaptor	Chief	CMA365	1
5	Hardware to mount to roof steel	Custom	\$300 Allowance	1
6	Electric Projection Sreen 392"D x 332"W x 207.5"H	Draper	Paragon E p/n 114228	1
7	Low Voltage kit w/ 3-Position Switch	Draper	121233	1
8	Wall Plate HDMI Encoder w/ Bluetooth	Visionary	DuetE5-WP-BT-Black	2
9	Projector HDMI Decoder	Visionary	D5200	1
N Equipment Rack				
1	Wall Mount Equipment Rack- AV ER4 Gym Rack	Middle Atlantic	EWR-1622	1

3	Cable Lacer Bars 2" Offset - 10pk	Middle Atlantic	LBP-1.5R90	1
6	1sp Blank Panel	Middle Atlantic	EB1	3
8	3sp Rack Drawer	Middle Atlantic	D3	1
12	Rack Mount Horizontal Power Distribution	Middle Atlantic	PDX-920R	1
13	Internal Work Light	Middle Atlantic	LT-GN-WL	1
22	TechFlex, 1.25"-2.75" expandable tubing	TechFlex	PET8-50-BK	1
23	Cable Management, in rack, vertical cable tray	Hellerman, equal	2x2, 3x3	1
O Networking				
1	24 Port L3 Network Switch M4250 series	Netgear	GSM4230P	2
P Custom Panels, Patch Cables				
1	Small Wall Box for HDMI Wall Plate	FSR	WB-X1-GNG	2
2	Flush Mount Cover for Small Wall Box-White	FSR	WB-X1-CVR-WHT	1
3	Surface Mount Cover for Small Wall Box-Black	FSR	WB-X1-SMCVR-BLK	1
S Wire & Cable				
1	D2 - 50ohm RG-8/U Coaxial Cable - 1 Foot	Belden	9913	100
2	D3 - 4x23 AWG Twisted Pair, CAT6A, Foil Shield - 1000'	West Penn	4246AF	1
3	G1 - 2x 14 AWG Stranded Copper w/ PVC Jacket - 1000'	West Penn	226	3
4	LOT, Pre-made Cables for all Interconnect	Custom	\$250 Allowance	1

PART 3 – EXECUTION

3.01 QUALITY ASSURANCE AND WORKMANSHIP

- A. The Audio Video System Contractor shall follow good working practices and fabricate and install items in accordance with the manufacturer's recommendations and the Consultant's specifications. Provide quality control procedures acceptable to the Owner and Consultant. Provide a properly qualified site supervisor who shall carry out supervision duties only. Provide straight, plumb, true and aligned components throughout, and shall consult with other trades doing related work and adjoining work in order to provide an installation of first-class quality.
- B. The Consultant reserves the right to reject any part of the installation not in compliance with the Contract Documents. The Audio Video System Contractor shall carry out any necessary remedial work or replacement free of charge and without delay to the Owner.
- C. A standard reference guide for the design, engineering, and installation of the Audio Video System shall be Audio System Design and Installation, by Philip Giddings (Sams Publishing).

3.02 DEFINITIONS

- A. Electrical Reference:
 - 1. The following electrical references are used throughout the Audio Video System specification:
 - a. Voltage: $\text{dBv} = 20\log(E1/E2)$
 - b. Power: $\text{dB} = 10\log(P1/P2)$
 - c. $0\text{dBu} = 0.775\text{VRMS}$; ratio of voltages measured open circuit
 - d. $0\text{dBv} = 0.775\text{VRMS}$; ratio of voltages measured open circuit
 - e. $0\text{dBV} = 1.0\text{VRMS}$; ratio of voltages measured open circuit
 - f. $0\text{dBm} = 1\text{mW}$; power level (typically 0.775V into 600-ohm load)
 - g. $0\text{VU} = +4\text{dBm}$; power level referenced to 600 ohms
- B. Electrical Characteristics:
 - 1. Unless otherwise specified in the Contract Documents, electrical characteristics of the Audio Video System equipment shall be as follows:
 - a. Microphone preamplifier inputs shall be balanced, have an impedance greater than or equal to 1.2k ohms , and designed to be driven from sources of 600 ohms or less.
 - b. Line inputs shall be balanced bridging, have an impedance greater than or equal to 10k ohms , and designed to be driven from sources of 10k ohms or less.
 - c. Line outputs shall be balanced, have an impedance less than or equal to 100 ohms , and designed to drive loads of 600 ohms or greater.
- C. Connector Polarity: Proper polarity of connectors on combination panels, receptacle plates, rack panels, patch panels, and other devices fabricated and/or wired by this Contractor shall be established as follows: Polarity of connectors for OEM devices and equipment may be different, and should be wired to patch panels so as to maintain consistent system polarity.
 - 1. Microphone and Line Level
 - a. Balanced Connection

XLR-3 connectors: pin 1 = ground/shield (do not connect to case); pin 2 = high ("hot"); and pin 3 = low ("cold").

$\frac{1}{4}"$ T/R/S phone connectors: sleeve = ground/shield; ring = low ("cold"); and tip = high ("hot").
 - b. Unbalanced Connection

XLR-3 connectors: pin 1 = ground/common/shield (do not connect to case); pin 2 = high ("hot"); and pin 3 = tie to pin 1 only.

¼" T/S phone connectors: sleeve = ground/common/shield; and tip = high ("hot").

Phono (RCA) connectors: sleeve or shell = ground/common/ shield; and center pin = high ("hot").

2. Multiconductor Application
 - a. Multipin connectors: Refer to the manufacturer's specifications.
3. Data Connection
 - a. RJ45 connectors: Refer to the manufacturer's specifications.
4. Video and RF Level
 - a. BNC-type connectors: sleeve or collar = ground/shield; and center pin = signal ("hot").
5. Low Impedance Loudspeaker Level
 - a. Neutrik NL4 series connectors used for bi-amplified or passive (mono-amplified) Audio Video System loudspeakers: pin "1+" = Low frequency or full-range driver "+"; pin "1-" = Low frequency or full-range driver "-"; pin "2+" = High frequency driver "+"; pin "2-" = High frequency driver "-".
 - b. Neutrik NL4 series connectors used for 70.7 volt lines: pin "1+" = high ("hot"); pin "1-" = N/C; pin "2+" = N/C; and pin "2-" = low ("common").
- D. Transducer Polarity: Proper polarity of electro-acoustic transducers shall be established as follows, with exceptions as noted:
 1. Microphone
 - a. Positive acoustic pressure on the microphone diaphragm produces a positive voltage on pin 2, with respect to pin 3 of the output connector.
 2. Loudspeaker
 - a. Positive voltage applied to the (+) terminal produces a displacement of the loudspeaker cone away from the magnet, thus producing a positive acoustic pressure.

3.03 INSTALLATION

A. General:

1. All equipment except portable equipment shall be securely held in place with a safety factor of at least three; except that all equipment rigged overhead shall be so done using safe rigging practices and with rated hardware selected to meet a safety factor of at least ten. All equipment shall be installed in such a fashion as to present no safety hazard to operating personnel.
2. All equipment shall be adequately ventilated when operating under worst-case power dissipation.
3. All metal cabinets connected to the Audio Video System audio ground network shall be effectively isolated from any conduit or other metallic component that is connected to the building electrical safety ground.
4. All installation work shall be carried out in a neat and orderly fashion.

B. DSP and Control Systems Programming:

1. The audio systems for spaces described above will be controlled through a Digital Signal Processing System. This will provide all equalization, cross-over settings, level control, muting, routing, level monitoring, etc. With direction from the AV Consultant, the AV Contractor will develop signal flows for each of the systems as well as comprehensive GUIs for typical day-to-day operational control. These control screens will be accessible through both wired and wireless computers and wireless touch screen tablets. Several levels of user access are expected.

2. Pages will be formatted and sized appropriately for display resolutions of the control computers and wireless tablets. Multiple versions of some pages may be required to work with different display resolutions.
 3. Control Systesms (Q-SYS)
 - a. Provide control and monitoring of display devices, playback devices, audio Digital Signal Processing, and other AV equipment as applicable.
 - b. Wired touchscreen user interfaces will control technical system in each space. Each user interface will be tailored for the specific control needs based on the intended user and installed location. All user interfaces will be configured to operate in two modes.
 - 1) Simple User Mode: Control will include, but not limited to the following:
 - a) System Power on/off
 - b) Muting the System
 - c) Level control for RF Microphones
 - d) Projector Input Source Select
 - e) Bluetooth Level Control and Pairing
 - f) In the Cafeteria, automatic deployment of screen and projector when an HDMI source is plugged into the wall plate.
 - 2) Advanced User Mode: Control will include, but not limited to the following:
 - a) Muting the system
 - b) Allow for control of system thru Sound Mixer
 4. Completed base programming and structure will be tested and operational during the system commissioning.
 5. Two major owner requested revision lists to functionality and GUI layout will be incorporated into the control system programming during the first year of building operation after the first systems use.
 6. Control system and DSP programs are the ownership of the client and it shall be given to the client via flash drive at the end of the system warranty period.
- C. Wiring:
1. Ensure by drawing review and field survey that the conduit/raceway infrastructure is sufficient for the proper installation of the specified and required wire and cable, and/or any approved-substitute types of wire and cable.
 2. Do not begin pulling Audio Video System wiring through the Audio Video System Empty Conduit System until all conduit, pull boxes, etc. for each given run (point-to-point) are completely installed by the Electrical Contractor and ready for such wire and cable installation. Undertake a field inspection of the conduit system and pull boxes, reporting any missing conduit, harp edges, missing bushings or drag lines, blocked runs, etc., prior to attempting installation of wire and cable.
 3. The Audio Video System Contractor shall ensure that the wire and cable is installed in a manner that shall neither cause nor permit damage to the wire and cable throughout the installation process. Damaged wire and cable (including wire and cable spliced in violation of specified requirements) shall be rejected and replaced by this Contractor at no cost to the Owner.
 4. All microphone level, line level, video/RF level, Data level, low impedance loudspeaker level, and AC power level wiring shall be restricted to individual and separate conduit systems.
 5. All microphone and line level wiring shall be balanced and floating, unless otherwise indicated.
 6. Take all necessary precautions to prevent electromagnetic, electrostatic, and radio frequency interference.
 7. Care should be taken in wiring and installation to prevent damage to wire or equipment. All wire entering racks or other equipment shall have a service loop of at least four (4)

feet unused (slack) length after termination. This service loop shall be neatly bundled and harnessed in place.

8. No splices shall be allowed in microphone, line level, video/RF or data cables unless it is physically impossible to install the wire in one length. Splices must be approved by the Consultant on a case-by-case basis. When approved, the following splicing methods may be used:
 - a. Crimp-type “butt” splice connectors with an appropriately sized shrink tube for each conductor, as well as an overall shrink tube for all audio and intercom cable types.
 - b. Female BNC “barrel” connectors for video/RF cable. Male BNC connectors shall be provided on cable ends at location of the splice.
 - c. Female 8P8C (commonly known as RJ45) “barrel” connectors for Data cable. Male 8P8C connectors shall be provided on cable ends at the location of the splice.
 - d. Splices in loudspeaker cable are permitted without prior approval by the Consultant. Such splices shall be kept to a minimum.
 - e. Any splices made shall occur only at junction boxes, pull boxes or other permanently accessible locations. Such splices shall be listed on a schedule provided with the as-built documentation.

D. Flexible Cords and Cables:

1. Flexible cords used shall be selected giving consideration to ambient and conductor temperatures, wear-resistance, flexing, and mechanical stress. Vulcanized rubber, butyl rubber, EP, or silicone rubber insulated cables shall be used in preference to PVC insulated types, wherever possible. All flexible cords and cables shall comply with the current edition of the applicable local Electrical Codes and appropriate regulations as identified in “Part 1 - General: Safety and Code Requirements”.
2. Flexible cables used as hanging or trailing leads, for power or control circuits, shall comply with the previous clause and shall, if under tension, be fitted with a strain-relief center core that shall be clamped at both ends to relieve the strain on conductors. Trailing leads shall be of a suitable length for the actual application.
3. The segregation of conductors carrying different category circuits shall be as defined in the applicable regulations (local, state and national Electrical Codes and elsewhere herein) and shall be maintained in all flexible cables used. Adequate insulation shall be ensured on all multicore and control circuits.
4. Where the final connection to any equipment is by means of a flexible cable, such flexible cable shall have the same current rating as the rest of the circuit. The current ratings for the ambient temperature shall be as given in the applicable local Electrical Code.

E. Labeling and Marking:

1. All Audio Video System wire and cable shall be logically and permanently marked by the Audio Video System Contractor. All wire shall be identified at each termination point, and shall be marked to indicate the discrete destination (i.e., a wire shall show the reference number of the jack or connector to which its other end is terminated). All cable markers shall bear the alphanumeric characters of the circuit shown on the approved shop drawings.
2. Wire and cable shall be marked with an approved system of durable identification markers, such as slip-on type PVC or neoprene sleeves, or with directly heat stamped characters. The use of computer-generated labeling systems, such as the Brady DAT-34 or DAT-37, is recommended. Cloth, vinyl or P-Touch tape-type markers are not acceptable.
3. The individual pairs of multipair cable and individual conductors of multiconductor cable shall be readily identified by permanent color coding of the wire insulation. Multipair or

multiconductor cable that is identified only by means of the form or order of lay of individual wire is not acceptable.

4. All spare wire shall be marked "spare" at both ends and numbered consecutively. A "spare schedule" shall be provided indicating spare wire and cable numbers, locations and types.

F. Termination:

1. All connections and joints shall be made with rosin-core solder or an approved mechanical connector.
2. All multipin connectors shall have crimp-type gold-plated contacts.
3. All Contactor-terminated data cables & connections must be "certified" using industry-standard testing and verification equipment.
4. Where flexible cable joins fixed wiring the terminations shall be accomplished with either a pair of appropriate mating connectors or a suitable terminal block.
5. All terminations of shielded cables shall consist of a PVC or neoprene heat shrink sleeve covering the shield drain wire and an overall PVC or neoprene heat shrink sleeve covering the point at which the cable jacket and shield end.

G. Audio Grounding:

1. All shielded cables shall have their shields isolated from both the conduit system and any other shielded cables. Shields shall be continuous from source to input points. Shields shall be connected at input points only, with shields lifted at the source, except as noted below.
2. Microphone wiring shall have continuous shields from the microphone receptacle to microphone patch jack.
3. Tie-line patch points shall have continuous shield connection from one patch jack to another with no permanent connection to the audio ground network.
4. Unbalanced wiring, such as used in certain communication systems, shall have audio shields connected at device inputs and floated at device outputs. Strap shield to "low" side of unbalanced input.
5. No "doubling up" of ground points on multipin connectors or terminal blocks shall be allowed.

H. AC Power System:

1. AC power for the Audio Video System, provided by the Electrical Contractor, is distributed at 120VAC, 60Hz. Refer to the electrical plans for further information.

I. Grounding:

1. The Audio Video System audio ground network ("audio ground"), including ground source, ground conductors, and ground distribution points is provided by the Electrical Contractor. The isolation and ground continuity of this network, although the responsibility of the Electrical Contractor, shall be confirmed by the Audio Video System Contractor prior to installation of equipment. Any ground shorts or faults shall be reported for correction by the Electrical Contractor.
2. The audio ground network shall be isolated from all other electrical grounds except at the source of the ground network, the building safety ground, specified to be of high quality. Therefore, if the connection between the audio ground network and the source of the ground is disconnected, no continuity between the audio ground and the building electrical ground shall exist.
3. The Audio Video System audio ground network connects all Audio Video System equipment positions together by a single, low impedance, ground network. All AC power wall receptacles in Audio Video System areas, provided by the Electrical Contractor unless otherwise indicated, will be the isolated ground type, connected only to the associated audio ground spur in that area.

4. All Audio Video System equipment racks containing active electronics shall be connected to the audio ground network, except as otherwise noted in this specification. Caution must be exercised so that these racks are not permanently, or in any way during operation, capable of being accidentally connected to the building safety ground.
 5. All conduits and back boxes containing Audio Video System wiring shall be permanently connected to the building electrical safety ground.
 6. Video (RF) and infrared (RF) devices, being unbalanced in nature, shall not be connected to the Audio Video System audio ground network.
- J. Electrical Safety:
1. No voltage in excess of 25V rms AC or 24V ripple free DC shall be exposed to touch in normal use or in any equipment by the withdrawal of modules or of any plug or connector or without the removal of suitably indelibly labeled covers.
 2. Unless specifically excepted, all live electrical parts above 50V rms AC or 60V ripple free DC, including terminals, shall remain completely shrouded by insulation or grounded metal when the main access panels are removed. The separate shrouds or covers shall require a tool to remove them to prevent inadvertent contact with live parts.
 3. In addition, where enclosures or items of equipment containing predominantly control, computer, or similar low voltage signals also contain voltages in excess of 50V rms AC or 60V ripple free DC, clear standard warning notices indicating the maximum voltage present shall be provided on all removable access panels. Similar warning notices shall be provided where voltages exceeding 120V are present in any enclosure or item of equipment and such a voltage would not reasonably be expected to be present.
 4. Within enclosures, racks and panels identify with prominent, standard, and indelible signage, which circuit breakers or disconnects are to be switched off in order to isolate the equipment totally. Warning notices shall also be provided on all equipment that contains live terminals after operation of its circuit breaker or disconnect. These terminals must be completely shrouded to prevent inadvertent contact.
 5. All equipment, control stations, equipment racks, enclosures, and all metal cases, raceways, and conduit shall be efficiently grounded. Special hand held or portable equipment that is not double insulated shall have duplicated grounding connections. All grounding shall be in accordance with the current edition of the applicable local, state and national Electrical Codes and as identified within this Section and Division 13.
- K. Control System Voltage:
1. Control circuits shall generally be operated at a maximum of 24V AC or DC as appropriate, and in compliance with the protection described. Hand held control panels shall not contain line (120V) voltage unless approved. Special arrangements to feed movable panels with both line voltage and control voltage must provide suitable mechanical protection and ensure separation of services using the correct category of cable as defined in the codes and regulations identified in "Part 1 - General: Safety and Code Requirements".
- L. Equipment:
1. Operating parts of all equipment shall be suitably machined and finished. Tolerances, fits, finishes, etc., where not specified herein or indicated on the drawings, shall conform to best trade practices and the operational intent of the equipment.
 2. All components shall be of new or recent manufacture, built within two (2) years of the date of installation and never used prior to installation.
 3. All components and items used in Audio Video System shall be by a recognized manufacturer specializing in professional Sound and electrical equipment and shall conform to applicable industry and code standards.

4. The quality of workmanship and materials of all equipment and components requiring custom fabrication shall be comparable to that of professional audio equipment as produced by specialized original equipment manufacturers.
 5. All components used in the equipment installations shall be selected on the basis that each item, or a similarly performing substitute, will be obtainable by the Owner for a period of five (5) years should further spares be required.
 6. All electronic components shall be readily available from at least two recognized manufacturers.
 7. Custom firmware (EPROM, ROM, etc.) shall be supported by readily available spares.
 8. All equipment forming part of a given system or installation, and all like components, spares and replacements shall be electrically and mechanically interchangeable.
 9. Electrical and electronic components shall be selected for long operating life and reliability. The design of components and assemblies shall ensure that all such components work at a minimum of 25% less than their maximum ratings.
 10. All integrated circuits containing program code and all circuits with twenty four or more pins shall be mounted in sockets.
 11. All indicators, controls, fuses, relays, contactors, printed circuit cards, and other major components shall each be fitted with a permanent label indicating their type, rating, and duty to expedite any necessary replacement or fault finding. Where applicable, a means of identifying normally open, normally closed, and other contact configurations shall be marked on the component.
 12. Annunciators, indicators, and fuses in individual power and electronic systems shall be standardized and approved by the Consultant before design is finalized. Indicating devices shall be of as few different types as possible and wherever practicable shall have a minimum life of 10,000 hours.
 13. All contactors and relays (although not necessarily special approved types such as reed relays) shall be of the snap-track type developed for mounting inside equipment rack. Generally the contact rating shall be twice the expected maximum operating or inrush current whichever is the greater.
 14. Fuses and circuit breakers shall be panel mounted. Fuses shall be mounted in indicating fuse holders, illuminated when the fuse has failed. Where fuses must be concealed they shall be easily accessible. All panels with concealed fuses shall be marked accordingly on the outside and shall have panel mounted indicator lights. Spare fuses shall be provided in holders mounted within the panel.
 15. All internal switches shall be clearly and permanently labeled.
 16. All connectors external to the equipment shall be of rugged metal construction with self-contained locking devices. Nonmetallic external connector shells are unacceptable.
 17. All keyswitches and keylocks for similar components shall use the same key. Unless otherwise specified, keys shall be removable in all positions. Supply four (4) key copies for each keyswitch/keylock.
 18. All edge connectors, ribbon cable connectors and headers shall have gold-plated contacts. All IC sockets shall be of a face-wipe, gas-tight design.
- M. Assemblies:
1. Manufacturing, assembly, and wiring work shall be carried out by trained and experienced technicians.
 2. Ensure that all parts and components of electrical, electronic, or computer installations are readily accessible for inspection, service, and maintenance. All components shall be replaceable without removal of operational components other than those mounted on or carrying the faulty component. All parts shall be replaceable without strain or damage to other parts.

3. Electrical and electronic systems shall be constructed as separately removable modules. Where a system comprises a large number of similar modules, these modules shall be designed so as to be easily interchangeable. Where such equipment is of a plug-in type, withdrawing or replacing the modules with the power "on" shall not cause damage to the units or to other equipment.
4. Electrically dissimilar modules or connectors shall not be able to be wrongly connected. Operating surfaces of control panels/consoles shall be of steel, aluminum, or other rigid material, reinforced where necessary to prevent noticeable panel deflection. Generally, all sides of a control panel shall be fully supported.
5. Where possible all control and connection panels shall have hinging or drawer access to electronics for installation and maintenance. Panels shall be held closed by captive quick locking hardware. Provide terminal strips, and neatly bundled wiring to facilitate access. Captive fasteners shall be provided for all removable panels or parts. Any inaccessible nuts shall be fixed. Countersunk or instrument head screws shall be used on external surfaces.

N. Custom Fabrication:

1. Particular attention shall be paid to the selection of operational components used on custom pendants and control panels. All such components shall be selected for long life under arduous conditions, including rough use in a dusty and dirty environment.
2. Pushbuttons, selector switches, key switches, operating knobs, handles, and similar shall all be rugged industrial-type components, firmly mounted and capable of giving long trouble-free service. Commercial-grade units will not be accepted.

O. Finishes:

1. Unless otherwise indicated, all steel equipment cabinets and panels shall be finished with one coat of primer and two coats of semi-gloss baked enamel after full degreasing and rust preventing processes. Colors shall be as selected by the Consultant or as specified herein.
2. Aluminum panel surfaces shall be anodized black or other color as indicated herein or on the drawings.
3. Finishes subjected to high temperatures shall be of heat-resistant epoxy or other durable high-temperature baked-on enamel finish.
4. Finishes shall be durable and capable of withstanding normal usage in the areas in which they are installed.

P. Equipment Racks:

1. All internal wiring of electrical, electronic or computer equipment shall be in accordance with the current editions of the applicable Electrical Code and governing regulations as identified in "Part 1 - General: Safety and Code Requirements".
2. All internal wiring shall be of adequate mechanical strength as well as electrical current rating. Multistrand cables shall be used for low current wiring in preference to solid conductors. The current carrying capacity of all cables within equipment enclosures shall take account of de-rating factors and ambient temperatures in accordance with applicable local, state and national Electrical Code regulations.
3. All terminal strips shall be logically positioned and indelibly marked in accordance with the circuit drawings. Generous space shall be left for installation of the external cables.
4. All terminals, to which connections are to be made by Division 16, shall have clear markings that are unique for each terminal and are as identified on the shop drawings.
5. All internal wiring shall be color coded and contained within raceways. At least 40% space shall be available as initial spare capacity. All the conductors of a given power circuit shall be contained within the same conduit or raceway. All internal wiring shall be protected from mechanical damage.

Q. Labeling:

1. All wall receptacle plates shall be engraved and filled to indicate the reference number of the circuit to which each is attached. Such numbers will, when applicable, be referenced to the patch panel jack to which the circuit connects. Refer to the contract drawings for reference numbers and designations.
 2. Panels and receptacles must be readable in dim lighting. Quality of engraving and filling, letter sizes, etc. shall comply with "Part 2 – Products: Receptacle Plates" of this specification and as approved by the Consultant through shop drawing and sample submittal.
 3. All legends shall be engraved and filled in a color as indicated on the drawings, unless otherwise noted below.
 4. Where required, engraved, adhesive-backed lamaroid labels shall also be mechanically fixed in place only in those cases where there is no risk of damage to a device's internal components or wiring.
- R. Noise from Equipment
1. The residual noise and hum output of the systems shall be such that PNC-15 or below can be measured at the center of main floor, and the character of the remaining noise must be random, with no audible discrete frequency components.
 2. Where a control panel or rack is to be used or located in an operational area, such as on stage, a gallery, or control room, there shall be no acoustic noise associated with the panel. No internal cooling fans or similar moving or magnetic equipment shall be permitted unless approved by the Consultant in writing.
 3. Operation of switches, pushbuttons, relays, solenoids, and similar shall not be audible to members of the audience (even in the control rooms with the window open).
- S. Spare Parts
1. Supply spare parts to be stored on-site for all user serviceable equipment and systems. A sufficient quantity of bulbs, fuses, knobs, switches, and other miscellaneous parts shall be supplied. Refer to "Part 2 - Products" for spares of electronic and transducer parts to be supplied.
 2. Label all spare parts with manufacturer's part number, designation, description, and location(s) where part is used. Provide neatly labeled storage containers for all spare parts, including special static free wrapping for electronically sensitive parts.
 3. The spare parts shall be released to the Owner after completion of the commissioning procedure.
- T. Site Work
1. The Audio Video System Contractor shall be responsible for delivery, storage and handling of equipment and tools during the period of the installation.
- U. Painting
1. Except for special requirements as approved by the Consultant, each painting system shall use paint products of one manufacturer to ensure compatibility of primer and undercoat with top coats.
 2. All paint products shall be factory prepared of the best grade and quality (front line) produced by the manufacturers, subject to approval by the Consultant.
 3. Finish coats on components exposed to view at all locations shall be two (2) coats of approved finish.
 4. The Audio Video System Contractor shall be held wholly responsible for the finished appearance of the painting work. Painting will be in accordance with the highest standards of the trade.
 5. All components exposed to view shall be shop painted to match approved samples.

6. Re-touch all shop painted or finished work wherever necessary or as directed, including unpainted screws and other fasteners. Prime paint all patched portions in addition to all other specified coats.

V. Protection Of Work

1. Shipping and Storage

- a. The Audio Video System Contractor shall be responsible for the satisfactory packing and protection of all components and materials for shipment from the factory to the site. Any items suffering damage during transit due to unsatisfactory packing shall be replaced without charge to the Owner.
- b. All equipment shall be packed to withstand the intended method of transport and environmental conditions expected. This Contractor shall take full account of the effects of rough handling, temperature extremes, dust, heavy rain, direct sunlight, and high relative humidity (up to 99%) during transit and installation. The packing shall, where necessary, reduce the effects of condensation.
- c. All equipment shall be packed in sturdy containers to provide mechanical protection during shipping and storage. Provide padding, etc., as necessary to protect the equipment from vibration and shock.
- d. Inner plastic sheeting shall be provided to protect the equipment from moisture and dust. Such covers shall be kept on equipment until environmental conditions have stabilized and the installation areas have been completed.
- e. No equipment shall be shipped to the job site by this Contractor until notification by the Contractor that storage facilities are available to protect the equipment prior to installation.
- f. The Audio Video System Contractor shall be responsible for storage and protection of portable equipment and components until turning these items over to the Owner during commissioning. Instruct the Owner as to the proper method of storage and protection of the equipment during installation.
- g. Refer also to the General Conditions, as amended by the Supplementary Conditions.

2. Installation

- a. Installation shall be authorized only when site conditions provide mechanical, electrical, and environmental protection suitable for the electronic equipment.

3. Special Protection of Electronic Equipment and Cable

- a. This Contractor shall conform with the following minimum standards and procedures for the storage and protection of the equipment during installation:
- b. Class 1 - Cable and distribution apparatus, back boxes, face plates, terminal boxes, and rack frames may be stored and installed in weather-protected spaces under "normal" construction site conditions provided that no electronic components are contained within devices and provided that storage boxes are sturdy, well sealed, and devices are protected with imperforate inner plastic sheeting. When installed, devices must be protected from dirt, dust and moisture by sturdy impermeable plastic sheeting, and completely covered with heavy corrugated cardboard, held in place securely by duct tape. Covers shall not be removed until the area is broom cleaned. Care shall be taken to prevent damage and prolonged exposure to improper site conditions during installation. In no case shall devices remain uncovered overnight during installation or while work is taking place causing high dirt dust or moisture levels in the area of placement.
- c. Class 2 - Control panels, spare parts, and test equipment (except as listed under Class 3) shall be protected and treated as per the Class 1 devices with the following additional provisions: Equipment shall be stored in an air-conditioned secure space. Equipment shall not be shipped until such space exists on site and is approved by the Consultant and Contractor. Control panels with electronic components may be

installed providing they are protected as described under Class 1 description above, but electronic components must be removed and shall not be installed until the area of installation is broom cleaned and all dirt, dust and moisture producing work is completed in the area. All other equipment in this class shall not be installed until the area of installation is broom cleaned, “blown” clean with pressurized air, mopped, secure, and air conditioned.

- d. Class 3 - Mixing consoles, filled equipment racks, and other electronic equipment shall not be shipped to site until the control rooms are finished, air conditioned, dust free, broom and mop cleaned, secure, and in all respects complete and ready for occupation. This class of equipment shall not be unpacked until the system is complete in all other respects. Under no circumstances may any equipment in this class be removed from the control rooms into or through spaces that are not cleaned, air conditioned, and complete.

3.04 TESTING AND ADJUSTMENT

A. General

- 1. Perform tests and adjustments to the Audio Video System as outlined in this specification. These tests and adjustments shall be completed at the time(s) specifically indicated in “Part 1 - General: Commissioning.”
- 2. Provide a minimum of two qualified technicians to assist in tests, adjustments, and final modifications during the testing and adjustment period.

B. Preparation

- 1. Ensure that all equipment racks, panels, and back boxes have been adequately cleaned of dirt, dust, and debris. Reassemble all equipment and replace all panels and covers with the necessary screws and/or other appropriate hardware prior to the final site inspection.
- 2. Before applying AC power to Audio Video System equipment, perform a complete system inspection on the site to verify that all items are correctly installed and will operate safely as specified in the Contract Documents.
- 3. Verify also that each individual section of the Audio Video System has been correctly installed and is fully operational.

C. Conditions

- 1. Do not use any major control equipment intended for installation in the Audio Video System for the purpose of checking or testing wiring or circuitry until such time as requirements for “Class 3” equipment meet the environmental conditions described in “Special Protection of Electronic Equipment and Cable” above. Provide testing apparatus, substitute control equipment, or other devices for testing wiring and circuitry prior to the existence of these conditions at all locations of Audio Video System equipment.
- 2. Electroacoustic measurements shall only be made once all interior room finishes are completed and all performance equipment is in place and operational. Such equipment includes, but is not necessarily limited to, audience chamber seating, acoustic isolation doors, acoustic canopies, and acoustic control curtains and banners.

D. Test Equipment

- 1. The following test equipment, provided at the expense of the Audio Video System Contractor, shall be available on site during all testing and adjustment sessions, initial and final site inspections, and demonstration and instruction sessions. Provide all appropriate monitors, adapters, cables, and connectors necessary to interconnect the test equipment devices to each other and to the Audio Video System equipment.
 - a. Multi-Function Audio Signal Generator/Analyzer
 - 1) Neutrik Minirator MR2 / Minilyzer ML1, or approved equal
 - b. Digital Multimeter
 - 1) Fluke 77 IV Series, or approved equal.

- c. Polarity Testing System
 - 1) LA Audio PC90 or approved equal
- d. Impedance Meter
 - 1) Goldline ZM-1, or approved equal.
- e. Sound Level Meter
 - 1) MiniAnylyzer, approved equal
- f. Two-channel FFT-Based Electroacoustic Analysis System
 - 1) SIA SMAART
 - 2) General: Computer-based electroacoustic measurement system requiring proprietary equipment and a certified operator. Provides dual-channel FFT transfer- function measurements, phase response, delay locator and real-time analysis and ability to perform these measurements with test signals and with program (music) occurring during performances.
- g. Two-Way Radios
 - 1) Motorola UHF, or approved equal.
 - 2) Quantity: Six (6) , with spare battery & charger.
- 2. Requests for alternate test equipment shall be submitted to the Consultant for approval shall meet or exceed the manufacturers' published specifications for the above components. No exceptions. Nonprofessional test equipment, including "custom-built" components, shall not be acceptable.
- E. Procedure:
 - 1. Perform the following tests and adjustments to the Audio Video System. All test results and system adjustments shall be fully documented for inclusion in the Initial and Final Test Reports. Refer to "Part 1 - General: Commissioning".
 - 2. Continuity
 - a. All permanent Audio Video System wire and cable shall be tested for continuity after installation in conduit and before termination in panels or racks. Also test for shorting contact between any and all conductors in a multipair or multiconductor cable and between each conductor and the conduit (building safety ground). Use a continuity meter for all tests.
 - b. All Audio Video System wirepaths shall be tested to ensure that device inputs and outputs, assigned to particular circuits or channels, terminate to the correct location, and that all corresponding labeling is accurate.
 - c. Measure and verify electrical and electroacoustic polarity of all Audio Video System components to ensure that the entire system is properly connected (i.e., the system shall be "in phase"). Ensure that absolute polarity is maintained throughout all signal paths, regardless of patching or other routing changes.
 - d. Document all wiring or termination changes made in order to maintain system polarity.
 - 3. Impedance
 - a. Measure and document the impedance of each microphone and line level line terminated with a 600-ohm 1% precision resistor, at 250Hz, 1kHz, and 4kHz, while disconnected from any device input. The load impedance value shall be greater than the resistive load.
 - b. Measure and document the impedance of each low-impedance loudspeaker line to an unconnected receptacle, at the patch panel, terminated at the opposite end with an 8-ohm 1% precision resistor, at 250Hz, 1kHz, and 4kHz, while disconnected from any device input. The load impedance value shall be greater than the resistive load.
 - c. Measure and document the impedance of each low-impedance (nominal 2 to 8-ohm) loudspeaker line while disconnected from the power amplifier. The load impedance

- value shall be greater than the total rated impedance of all connected loudspeaker drivers.
- d. Test each full-range loudspeaker line at 63Hz, 250Hz, 1kHz, 4kHz, 8kHz, and 16kHz.
 - e. Test each band-limited loudspeaker line (i.e., bi-, tri-, or quad-amp systems) at the maximum number of test frequencies that fall within the frequency range of the driver under test.
 - f. Measure and document the impedance of each 70.7V loudspeaker line at 250Hz, 1kHz, 4kHz, and 8kHz, while disconnected from the power amplifier. The load impedance value shall be greater than the total rated impedance of all connected voice-coil transformers.
4. Radio Frequency Interference
 - a. Use a minimum 60 MHz bandwidth analyzer in conjunction with loudspeaker or infrared receiver/headset monitoring to ensure that the Audio Video System under test is free of spurious oscillation and radio frequency interference (RFI). Measure and document all results.
 5. Gain Structure
 - a. Set and document input and output gain controls on all Audio Video System components to provide appropriate signal balance (i.e. unity gain) and optimum signal-to-noise ratio for each signal path. Unity gain shall be set by adjusting the gain of each active device (excluding power amplifiers and mixer/amplifiers) for input level equals output level by using a reference signal of 0dBv pink noise at the mixing console output.
 - b. Ensure that a minimum of 18dB of headroom exists for each gain stage. The overall system gain (excluding mixer/preamplifiers, mixer/amplifiers, and power amplifiers) through any signal path from any input to any output shall be unity + 1.5dBv.
 - c. Conduct listening tests from center of coverage of each high-frequency horn device to determine that there is no audible hiss or distortion.
 6. Electronic Signal Path
 - a. Measure and document frequency response, signal to noise ratio (S/N), maximum output before clipping, total harmonic distortion (THD), and any spurious noise and/or hum signals of all electronic components in the Audio Video System. Measured values must be as published by the manufacturer, or better.
 - b. With unity gain levels set, measure and document electrical frequency response for all discrete signal paths from the mixer through each active device, including mixer/amplifier outputs with the loudspeaker lines disconnected. Also test typical signal paths through each combination of mixer input to output. Use a -60dBv (0.8mV RMS) sine wave signal at microphone inputs from 20Hz to 20kHz and a 0dBv (0.775 VRMS) sine wave signal from 20Hz to 20kHz at line level inputs. Deviation shall be within +/-1.0dBv from the range of 30Hz to 20kHz, or the specified bandpass for a particular circuit. (Refer to manufacturers' published data).
 - c. With unity gain levels set, measure and document signal to noise ratio for all discrete signal paths from the mixer through each active device with mixer input shorted.
 - d. Measure and document maximum output before clipping (headroom) and total harmonic distortion of each active device with methods recommended by the equipment manufacturer.
 - e. With unity gain levels set, measure and document any spurious noise and hum signals such as 60Hz, 120Hz with harmonics, high frequency oscillation, clicks, pops, or noise spikes for all discrete signal paths from the mixer through each active device, including the mixer/amplifier outputs with loudspeaker lines disconnected. If any unwanted signals are detected, troubleshoot and correct or modify as necessary.
 7. Power Output

- a. Measure and document the output power of each power amplifier and mixer/amplifier, using a sine wave oscillator with less than 0.5% THD as an input source. Terminate each power amplifier channel output with a load resistor to match the nominal loudspeaker impedance. Apply a 1KHz signal at a level to achieve 10 dB below full rated power output of the mixer/amplifier. Observe the sine wave with an oscilloscope to insure that full voltage for rated power can be reached without noticeable deformation of the waveform.
8. Buzzes, Rattles, Distortion
 - a. Apply a sine wave sweep at a slow rate from 30Hz to 10kHz at 6dB below full rated power output of each amplifier in the Audio Video System with output connections made to all loudspeaker drivers or voice-coil transformers. Adjust test frequency range to compensate for band-limited low-voltage loudspeaker lines (i.e., bi-, tri-, or quad-amp circuits) or 70.7 volt loudspeaker lines. Listen carefully to each loudspeaker for electromechanical buzzes, rattles, distortion, or other objectionable noises and correct all causes of such defects. If cause is outside Audio Video System equipment and/or the scope of this section of the contract, promptly notify the Owner and Consultant of the cause and suggested corrective procedure.
- F. Audio Video System Testing
 1. The following Audio Video System Tests shall be conducted as part of the SMAART measurement and optimization process. Audio Video System Testing will require two 8-hour sessions scheduled to ensure quiet ambient noise levels in the test area. The Audio Video System Contractor shall provide a certified SMAART technician to operate the SMAART System.
 - a. Sound Pressure Level: Measure and document sound pressure level of loudspeaker arrays throughout the seating areas and adjust suspended loudspeaker aiming, as necessary, to achieve a coverage of +/- 3dB, or better, with a peak continuous level of 105dB SPL. Take all readings at seated ear level height.
 - b. Loudspeaker Array Driver Alignment: Measure and document the loudspeaker driver alignment of the components of each loudspeaker array. Adjust precision signal delay units as necessary to achieve the best average signal alignment between adjacent components.
 - c. Frequency Response: Measure and document the frequency response of each loudspeaker array, as measured in both the reverberant field and near field (with windowed FFT methods), to ensure that the frequency response is within +/-3dB from 100Hz to 3kHz, and rolls off at a rate of 3dB/octave +/-3dB from 3kHz to 12kHz (and beyond, if possible). Apply the pink noise source at a line input of the mixing console. Adjust fixed Audio Video System equalization as necessary. If discrepancies arise, the final curve shall be based on the average of the values measured. Hard copy documentation shall be recorded for both time-energy-frequency analysis and ISO one- third octave band frequency response measurement.
 - d. Speech Intelligibility: Perform subjective and/or objective speech intelligibility measurements or surveys throughout the facility and make adjustments as necessary to the Audio Video System for maximum speech intelligibility. Submit proposed methods of testing to the Consultant for approval.

3.05 PROGRAMMING

- A. At the completion of the Testing process, and in conjunction with the Consultant, Project Architect and Design Team, and other trades, the Audio Video System Contractor shall provide full time technical support for ten (10) 12-hour days of Programming. Two (2) technicians shall be provided for the entire duration of the Programming period.

- B. Technical personnel should be prepared to adjust loudspeaker positions, facilitate required changes to Audio Video System equipment programming, and troubleshoot any technical problems that may arise during Ride Programming Sessions.

END OF SECTION

SECTION 28 07 21 FIRE ALARM AND DETECTION SYSTEMS

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. The work covered by this section is to be coordinated with related work as specified elsewhere in the specifications. Requirements of the following sections apply:
 - 1. Electrical
 - 2. Common Work Results for Electrical
 - 3. Water-Based Fire-Suppression System
 - 4. Clean Agent Fire Extinguishing Systems
 - 5. Heating, Ventilating, and Air-Conditioning (HVAC)
 - 6. Integrated Automation
- C. The system and all associated operations shall be in accordance with the following:
 - 1. Requirements of the following Model Building Code: IBC, 2015 Edition
 - 2. Requirements of the following Model Fire Code: IFC NFPA 1, 2015 Edition
 - 3. Requirements of the following Model Mechanical Code: IMC, 2015 Edition
 - 4. NFPA 72, National Fire Alarm Code, 2016 Edition
 - 5. NFPA 70, National Electrical Code, 2014 Edition
 - 6. NFPA 101, Life Safety Code, 2015 Edition
 - 7. NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems, 2015 Edition
 - 8. ANSI/ASME A17.1 / CSA B44, Safety Code for Elevators and Escalators, 2013 Edition
 - 9. ICC/ANSI A117.1 Accessible and Useable Buildings and Facilities, 2015 Edition
 - 10. Local Jurisdictional Adopted Codes and Standards
 - 11. ADA Accessibility Guidelines

1.2 SUMMARY

- A. This Section covers fire alarm systems, including initiating devices, notification appliances, controls, and supervisory devices.
- B. Work covered by this section includes the furnishing of labor, equipment, and materials for installation of the fire alarm system as indicated on the drawings and specifications.
- C. The Fire Alarm System shall consist of all necessary hardware equipment and software programming to perform the following functions:
 - 1. Fire alarm system detection and notification operations.
 - 2. Control and monitoring of elevators, smoke control equipment, door hold-open devices, fire suppression systems, emergency power systems, and other equipment as indicated in the drawings and specifications.
 - 3. Two-way supervised firefighter's phone operations.
 - 4. One-way supervised automatic voice alarm operations.

1.3 DEFINITIONS

- A. ADA: Americans with Disabilities Act
- B. AHJ: Authority Having Jurisdiction
- C. ANSI: American National Standards Institute
- D. ASME: American Society of Mechanical Engineers
- E. FACU: Fire Alarm Control Unit
- F. FM: Factory Mutual
- G. IBC: International Building Code
- H. ICC: International Code Council
- I. IDC: Initiating Device Circuit
- J. IEEE: Institute of Electrical and Electronic Engineers
- K. IFC: International Fire Code
- L. IMC: International Mechanical Code
- M. IRI: Industrial Risk Insurers
- N. LED: Light-emitting diode.
- O. NAC: Notification Appliance Circuit
- P. NFPA: National Fire Protection Association
- Q. NICET: National Institute for Certification in Engineering Technologies.
- R. RAC: Releasing Appliance Circuit
- S. SLC: Signaling Line Circuit
- T. UL: Underwriters Laboratories
- U. ULC: Underwriters Laboratories, Canada

1.4 SCOPE OF WORK

- A. This section to be completed by Engineer. Detailed description of system goals, operational requirements including unique sequence of operations, working hours, and other PROJECT SPECIFIC items should be included that are not clearly addressed in other sections of this document.

1.5 SYSTEM DESCRIPTION

- A. General: Provide a complete, non-coded addressable, microprocessor-based fire alarm system with initiating devices, notification appliances, and monitoring and control devices as indicated on the drawings and as specified herein.
- B. Power Requirements
 - 1. The control unit shall receive AC power via a dedicated fused disconnect circuit.
 - 2. The system shall be provided with sufficient battery capacity to operate the entire system upon loss of normal AC power in a normal supervisory mode for a period of 24 hours with 15 minutes of alarm operation at the end of this period. The system shall automatically transfer to battery standby upon power failure. All battery charging and recharging operations shall be automatic.
 - 3. All circuits requiring system-operating power shall be 24 VDC nominal voltage and shall be individually fused at the control unit.
 - 4. The incoming power to the system shall be supervised so that any power failure will be

- indicated at the control unit. A green "power on" LED shall be displayed continuously at the user interface while incoming power is present.
5. The system batteries shall be supervised so that a low battery or a depleted battery condition, or disconnection of the battery shall be indicated at the control unit and displayed for the specific fault type.
 6. The system shall support NAC Lockout feature to prevent subsequent activation of Notification Appliance Circuits after a Depleted Battery condition occurs in order to make use of battery reserve for front panel annunciation and control.
 7. The system shall support 100% of addressable devices in alarm or operated at the same time, under both primary (AC) and secondary (battery) power conditions.
 8. Loss of primary power shall sound a trouble signal at the FACU. FACU shall indicate when the system is operating on an alternate power supply.
- C. Software: The fire alarm system shall allow for loading and editing instructions and operating sequences as necessary.
1. The system shall be capable of on-site programming to accommodate system expansion and facilitate changes in operation.
 2. All software operations shall be stored in a non-volatile programmable memory within the fire alarm control unit. Loss of primary and secondary power shall not erase the instructions stored in memory.
 3. Panels shall be capable of full system operation during new site-specific configuration download, master exec downloads, and slave exec downloads.
 4. Panels shall automatically store all program changes to the panel's non-volatile memory each time a new program is downloaded. Panels shall be capable of storing the active site-specific configuration program and no less than 9 previous revisions in reserve. A compare utility program shall also be available to authorized users to compare any two of the saved programs. The compare utility shall provide a deviation report highlighting the changes between the two compared programs.
 5. Panels shall provide electronic file storage with a means to retrieve a record copy of the site-specific software and up to 9 previous revisions. Sufficient file storage shall be provided for other related system documentation such as record drawings, record of completion, owner's manuals, testing and maintenance records, etc.
 6. The media used to store the record copy of site-specific software and other related system documentation shall be electrically supervised. If the media is removed a trouble shall be reported on the fire alarm control unit.
- D. History Logs: The system shall provide a means to recall alarms and trouble conditions in chronological order for the purpose of recreating an event history. A separate alarm and trouble log shall be provided.
- E. Recording of Events: The system shall be capable of recording all alarm, supervisory, and trouble events by means of system printer. The printout shall include the type of signal (alarm, supervisory, or trouble) the device identification, date and time of the occurrence. The printout shall differentiate alarm signals from all other printed indications.
- F. Wiring/Signal Transmission:
1. Transmission shall be hard-wired using separate individual circuits for each zone of alarm operation, as required or addressable signal transmission, dedicated to fire alarm service only.
 2. System connections for initiating device circuits shall be Class B, Style D, signaling line circuits shall be Class B, Style 4 and notification appliance circuits shall be Class B, Style Y.

3. Circuit Supervision: Circuit faults shall be indicated by a trouble signal at the FACU. Provide a distinctive indicating audible tone and alphanumeric annunciation.
 4. Constant Supervision Audio: When provided, audio notification appliance circuits shall be supervised during standby by monitoring for DC continuity to end-of-line resistors.
- G. Supplemental Notification and Remote User Access (Fire Panel Internet Interface)
1. Fire Alarm Control Unit (FACU) shall provide the necessary hardware to provide supplemental notification and remote user access to the FACU using Ethernet and TCP/IP communications protocol compatible with IEEE Standard 802.3.
 2. A standard RJ-45 Ethernet connection shall connect to the owner's Ethernet network. Provisions for that connection must be provided at each fire alarm control unit as part of the contract.
 3. The means of providing supplemental email and SMS text messaging notification shall be agency listed for specific interfaces and for the purpose described in this section. The use of non-listed external third-party products and interfaces is not acceptable.
 4. The fire panel internet interface shall be capable of sending automated notification of discrete system events via email and SMS text messaging to up to 50 individual user accounts and via email to up to 5 distribution lists.
 5. Each user account and distribution list shall be capable of being configurable for the specific type of events to be received. Each account shall be configurable to receive notification upon any combination of the following types of events:
 - a. Fire Alarm
 - b. Priority 2
 - c. Supervisory
 - d. Trouble
 - e. Custom Action Messages
 - f. Fire Panel Internet Interface Security Violations
 6. Each user account and distribution list shall be capable of being configurable for the specific content to be received. Each account shall be configurable to receive any combination of the following message content:
 - a. Summary
 - b. Event Information
 - c. Message
 - d. Emergency Contacts
 - e. Host Fire Alarm Control Unit Information
 7. Each user account and distribution list shall be capable of being configurable for the type of Fire Alarm Control Unit Logs and Reports to be received. Each account shall be configurable to receive any combination of the following Logs and Reports via email:
 - a. Alarm Log
 - b. Trouble Log
 - c. Analog Sensor Status Report
 - d. Analog Sensor Service Report
 - e. Almost Dirty, Dirty and Excessively Dirty Sensor Report
 - f. CO Analog Sensor Service Report

- g. Addressable Notification Appliance Candela Report
- h. Addressable Notification Appliance Status Report
- 8. Each user account and distribution list shall be capable of receiving email distribution of Fire Alarm Control Unit Logs and Reports On-Demand or automatically on a Pre-Determined schedule. Receipt of Logs and Reports shall be capable of being scheduled as follows:
 - a. Weekly
 - b. Bi-weekly
 - c. Monthly
- 9. The Fire Alarm Control Unit Logs and Reports shall be sent in CSV file format which can be imported into common database applications for viewing, sorting, and customization.
 - a. Each user account shall be capable of being configured to receive system events via email and/or SMS text messaging.
 - b. Each distribution list shall be capable of supporting up to 20 email address recipients.
- 10. The means to provide email notification shall be compatible with SMTP mail servers, ISP email services, and Internet email services. Communication with the email server shall be verified at selectable intervals of 5 to 30 minutes.
- 11. Email operation shall be capable of being disabled for service by the system administrator.
- 12. An email log shall be accessible to authorized users. The email log shall display the 25 most recent email notifications sent.
- 13. The fire panel internet interface for supplemental notification and remote user access shall support:
 - a. Secure HTTPS/SSL encrypted connections,
 - b. Up to 50 individual password protected user accounts,
 - c. Dynamic and Static IP addressing,
 - d. IP Address Blocking,
 - e. Restricted number of log-in attempts before lock-out configurable from 1 to 20,
 - f. Lock-out duration after unsuccessful log-in attempts configurable from 0 to 24 hours,
 - g. Email notification to Administrators of unsuccessful log-in attempts,
 - h. Automatic lock-out reset upon a new event,
 - i. Automatic inactivity logout configurable from 10 minutes to 24 hours,
 - j. Firmware updates over Ethernet,
 - k. Set-up and configuration via Local Service Port or via Remote Services over LAN/WAN connection
- 14. Authorized users shall be capable of accessing the fire alarm panel using a compatible web browser (Internet Explorer 6.0 or higher) and a secure HTTPS/SSL encrypted connection.
- 15. The fire panel internet interface shall support concurrent connections for up to 5 users plus 1 administrator.
- 16. Authorized users with remote access shall be capable of:
 - a. Viewing the fire panel internet interface web home page
 - (1) The fire panel internet interface home page shall display system status information and provide links to detailed status information and fire alarm panel reports and history logs

- (2) The web browser on the user's computer shall automatically refresh system status information upon a new event
 - (a) Systems that require a manual refresh to acquire updated system status information shall not be accepted
 - b. Viewing the fire alarm panel detailed card status information
 - c. Viewing the fire alarm panel detailed point status information
 - d. Viewing the fire alarm panel reports and history logs
 - e. Viewing the fire panel internet interface email log
 - f. Viewing system summary information
 - g. Accessing Custom Hypertext Links
- 17. The fire panel internet interface home page shall support customization to display the following information:
 - a. Customer Name and Address,
 - b. Fire Panel Location or Building Name,
 - c. Up to 10 Custom Hypertext Links with Text Descriptions

H. Remote Services Access:

- 1. Fire Alarm Control Unit (FACU) shall provide the necessary hardware to provide a remote service access feature using Ethernet and TCP/IP communications protocol compatible with IEEE Standard 802.3. The Remote Access feature shall provide automatic notification of system faults and remote diagnostics of system status for responding technicians prior to arrival on site.
- 2. A standard RJ-45 Ethernet connection shall connect to the owner's Ethernet network. Provisions for that connection must be provided at each fire alarm control unit as part of the contract.
- 3. The Ethernet access feature shall be agency listed for specific interfaces and for the purpose described in this section. The use of non-listed external third party interfaces is not acceptable.
- 4. The internet remote access service function shall provide automated real time off-site reporting of discrete system events to a remote service support center with details of internal FACU fault conditions allowing a pre-site visit analysis of repair requirements.
- 5. Existing FACU controls shall be capable of retrofitting the Remote Service module as a plug-in upgrade feature.
- 6. The remote service network shall work on the customers Ethernet infrastructure and be Fire-Wall friendly for two-way communications for off-site reporting. The feature shall be compatible with existing proxy servers and firewalls shall not require any special changes or modifications.
- 7. The remote service system shall be able to connect to the remote service center without the need for a VPN account or similar tunnel.
- 8. The remote service system shall be a non Windows based application to protect against conventional virus attacks.
- 9. The remote service system shall support a secure connection with strong encryption, 128 bit or better, and an optional secondary encryption method if required.
- 10. The remote service system shall be compatible with virtual LANS (VLAN).

11. The remote service system shall work on an outbound communication premise (panel calls home) in order to eliminate the possibility of any inbound connection into the network (from trusted or non trusted sites).
 12. The remote service system shall provide an audit trail of all events and service connections.
 13. The Remote Service connection will provide access for panel software downloads and uploads for archiving job specific programs back at the enterprise server.
 14. The supplier shall provide a service contract for the Remote Service program that provides the following requirements:
 - a. 24/7 recording of FACU service activity.
 - b. Off-site diagnostics by a technical specialist to provide repair and parts guidance to the service technician prior to a site visit.
- I. Required Functions: The following are required system functions and operating features:
1. Priority of Signals: Fire alarm events have highest priority. Subsequent alarm events are queued in the order received and do not affect existing alarm conditions. Priority Two, Supervisory and Trouble events have second-, third-, and fourth-level priority, respectively. Signals of a higher-level priority take precedence over signals of lower priority even though the lower-priority condition occurred first. Annunciate all events regardless of priority or order received.
 2. Noninterfering: An event on one zone does not prevent the receipt of signals from any other zone. All zones are manually resettable from the FACU after the initiating device or devices are restored to normal. The activation of an addressable device does not prevent the receipt of signals from subsequent addressable device activations.
 3. Transmission to an approved Supervising Station: Automatically route alarm, supervisory, and trouble signals to an approved supervising station service provider, under another contract.
 4. Annunciation: Operation of alarm and supervisory initiating devices shall be annunciated at the FACU and the remote annunciator, indicating the type of device, the operational state of the device (i.e. alarm, trouble or supervisory) and shall display the custom label associated with the device.
 5. Selective Alarm: A system alarm shall include:
 - a. Indication of alarm condition at the FACU and the annunciator(s).
 - b. Identification of the device /zone that is the source of the alarm at the FACU and the annunciator(s).
 - c. Operation of audible and visible notification appliances until silenced at FACU.
 - d. Closing doors normally held open by magnetic door holders.
 - e. Unlocking designated doors.
 - f. Shutting down supply and return fans serving zone where alarm is initiated.
 - g. Closing smoke dampers on system serving zone where alarm is initiated.
 - h. Initiation of smoke control sequence.
 - i. Transmission of signal to the supervising station.
 - j. Initiation of elevator Phase I functions (recall, shunt trip, illumination of indicator in cab, etc.) in accordance with ANSI/ASME A17.1 / CSA B44, Safety Code for Elevators and Escalators, when specified detectors or sensors are activated, as appropriate.

6. Supervisory Operations: Upon activation of a supervisory device such as a low air pressure switch, and tamper switch, the system shall operate as follows:
 - a. Activate the system supervisory service audible signal and illuminate the LED at the control unit and the remote annunciator.
 - b. Pressing the Supervisory Acknowledge Key will silence the supervisory audible signal while maintaining the Supervisory LED "on" indicating off-normal condition.
 - c. Record the event in the FACU historical log.
 - d. Transmission of supervisory signal to the supervising station.
 - e. Restoring the condition shall cause the Supervisory LED to clear and restore the system to normal.
7. Alarm Silencing: If the "Alarm Silence" button is pressed, all audible alarm signals shall cease operation.
8. Priority Two Operations: Upon activation of a priority two condition, the system shall operate as follows:
 - a. Activate the system priority two audible signal and illuminate the LED at the control unit and the remote annunciator.
 - b. Pressing the Priority 2 Acknowledge Key will silence the audible signal while maintaining the Priority 2 LED "on" indicating off-normal condition.
 - c. Record the event in the FACU historical log.
 - d. Transmission of priority two signal to the supervising station.
 - e. Restoring the condition shall cause the Priority 2 LED to clear and restore the system to normal.
9. System Reset
 - a. The "System Reset" button shall be used to return the system to its normal state. Display messages shall provide operator assurance of the sequential steps ("IN PROGRESS", "RESET COMPLETED") as they occur. The system shall verify all circuits or devices are restored prior to resetting the system to avoid the potential for re-arming the system. The display message shall indicate "ALARM PRESENT, SYSTEM RESET ABORTED."
 - b. Should an alarm condition continue, the system will remain in an alarmed state.
10. A manual evacuation (drill) switch shall be provided to operate the notification appliances without causing other control circuits to be activated.
11. WALKTEST: The system shall have the capacity of 8 programmable passcode protected one person testing groups, such that only a portion of the system need be disabled during testing. The actuation of the "enable one person test" program at the control unit shall activate the "One Person Testing" mode of the system as follows:
 - a. The city circuit connection and any suppression release circuits shall be bypassed for the testing group.
 - b. Control relay functions associated with one of the 8 testing groups shall be bypassed.
 - c. The control unit shall indicate a trouble condition.
 - d. The alarm activation of any initiating device in the testing group shall cause the audible notification appliances assigned only to that group to sound a code to identify the device or zone.
 - e. The unit shall automatically reset itself after signaling is complete.

- f. Any opening of an initiating device or notification appliance circuit wiring shall cause the audible signals to sound for 4 seconds indicating the trouble condition.
- 12. Install Mode: The system shall provide the capability to group all non-commissioned points and devices into a single "Install Mode" trouble condition allowing an operator to clearly identify event activations from commissioned points and devices in occupied areas.
 - a. It shall be possible to individually remove points from Install Mode as required for phased system commissioning.
 - b. It shall be possible to retrieve an Install Mode report listing that includes a list of all points assigned to the Install Mode. Panels not having an install mode shall be reprogrammed to remove any non-commissioned points and devices.
- 13. Module Distribution:
 - a. The fire alarm control unit shall be capable of allowing remote location of the following modules; interface of such modules shall be through a Style 4 (Class B) supervised serial communications channel (SLC):
 - (1) Initiating Device Circuits
 - (2) Notification Appliance Circuits
 - (3) Auxiliary Control Circuits
 - (4) Graphic Annunciator LED/Switch Control Modules
 - (a) In systems with two or more Annunciators and/or Command Centers, each Annunciator/Command Center shall be programmable to allow multiple Annunciators/Command Centers to have equal operation priority or to allow hierarchal priority control to be assigned to individual Annunciator/Command Center locations.
 - (5) Initiating Device Signaling Line Circuits
 - (6) Notification Appliance Signaling Line Circuits
 - (7) Power Supplies
 - (8) Voice System Amplifiers
- J. Analog Smoke Sensors:
 - 1. Monitoring: FACU shall individually monitor sensors for calibration, sensitivity, and alarm condition, and shall individually adjust for sensitivity. The control unit shall determine the condition of each sensor by comparing the sensor value to the stored values.
 - 2. Environmental Compensation: The FACU shall maintain a moving average of the sensor's smoke chamber value to automatically compensate for dust, dirt, and other conditions that could affect detection operations.
 - 3. Programmable Sensitivity: Photoelectric Smoke Sensors shall have 7 selectable sensitivity levels ranging from 0.2% to 3.7%, programmed and monitored from the FACU.
 - 4. Sensitivity Testing Reports: The FACU shall provide sensor reports that meet NFPA 72 calibrated test method requirements.
 - a. Reports shall be capable of being printed for annual recording and logging of the calibration maintenance schedule.
 - b. Where required, reports shall be accessible remotely through:
 - (1) A Fire Panel Internet Interface using Ethernet and TCP/IP communications protocol compatible with IEEE Standard 802.3. The Fire Panel Internet Interface shall be capable of automatically scheduling email reports to individual user accounts on a

weekly, bi-weekly, or monthly schedule

- (2) A PC Annunciator using an RS232-C connection to the FACU or a PC Annunciator Client using a TCP/IP communications protocol connection to the PC Annunciator server compatible with IEEE Standard 802.3.
5. The FACU shall automatically indicate when an individual sensor needs cleaning. The system shall provide a means to automatically indicate when a sensor requires cleaning. When a sensor's average value reaches a predetermined value, (3) progressive levels of reporting are provided. The first level shall indicate if a sensor is close to a trouble reporting condition and will be indicated on the FACU as "ALMOST DIRTY." This condition provides a means to alert maintenance staff of a sensor approaching dirty without creating a trouble in the system. If this indicator is ignored and the second level is reached, a "DIRTY SENSOR" condition shall be indicated at the FACU and subsequently a system trouble is reported to the Supervising Station. The sensor base LED shall glow steady giving a visible indication at the sensor location. The "DIRTY SENSOR" condition shall not affect the sensitivity level required to alarm the sensor. If a "DIRTY SENSOR" is left unattended, and its average value increases to a third predetermined value, an "EXCESSIVELY DIRTY SENSOR" trouble condition shall be indicated at the control unit.
6. The FACU shall continuously perform an automatic self-test on each sensor that will check sensor electronics and ensure the accuracy of the values being transmitted. Any sensor that fails this test shall indicate a "SELF TEST ABNORMAL" trouble condition.
7. Multi-Sensors shall combine photoelectric smoke sensing and heat sensing technologies. An alarm shall be determined by either smoke detection, with selectable sensitivity from 0.2 to 3.7 %/ft obscuration; or heat detection, selectable as fixed temperature or fixed with selectable rate-of-rise; or based on an analysis of the combination of smoke and heat activity.
8. Programmable bases. It shall be possible to program relay and sounder bases to operate independently of their associated sensor.
9. Magnet test activation of smoke sensors shall be distinguished by its label and history log entry as being activated by a magnet.
- K. Fire Suppression Monitoring:
 1. Water flow: Activation of a water flow switch shall initiate general alarm operations.
 2. Sprinkler valve tamper switch: The activation of any valve tamper switch shall activate system supervisory operations.
 3. Water flow switch and sprinkler valve tamper switch shall be capable of existing on the same initiating zone. Activation of either device shall distinctly report which device is in alarm on the initiating zone.
- L. Audible Alarm Notification: By voice evacuation and tone signals on loudspeakers in areas as indicated on drawings.
 1. Automatic Voice Evacuation Sequence:
 - a. The audio alarm signal shall consist of an alarm tone for a maximum of five seconds followed by an automatic digital voice message. At the end of the voice message, the alarm tone shall resume. This sequence shall sound continuously until the "Alarm Silence" switch is activated.
 - b. All audio operations shall be activated by the system software so that any required future changes can be facilitated by authorized personnel without any component rewiring or hardware additions.
- M. Speaker: Speaker notification appliances shall be listed to UL 1480.

1. The speaker shall operate on a standard 25VRMS or 70.7VRMS NAC using twisted/shielded wire.
 2. The following taps are available: 0.25W, 0.50W, 1.0W and 2.0W. At the 1.0W tap, the speaker has minimum UL rated sound pressure level of 84dBA at 10 feet.
 3. The speaker shall have a frequency response of 400 to 4000 Hz for Fire Alarm and 125 to 12kHz for general signaling.
- N. Manual Voice Paging
1. The system shall be configured to allow voice paging. Upon activation of any speaker manual control switch, the alarm tone shall be sounded over all speakers in that group.
 2. The control unit operator shall be able to make announcements via the push-to-talk paging microphone over the pre-selected speakers.
 3. Total building paging shall be accomplished by the means of an "All Call" switch.
- O. Constant Supervision of Non-Alarm Audio Functions
1. When required, the system shall be configured to allow Non-Alarm Audio (NAA) functions such as background music or general/public address paging.
 2. During NAA operation, the speaker circuit shall be electrically supervised to provide continuous monitoring of the speaker circuit.
 3. During an alarm condition, supervision shall be disabled and alarm signals delivered to speakers.
- P. Addressable Notification Appliances
1. Monitoring: The FACU shall monitor individual addressable notification appliances for status, condition, type of appliance, and configured appliance settings. A fault in any individual appliance shall automatically report a trouble condition on the FACU.
 2. Individual Appliance Custom Label: Each addressable appliance shall have its own 40-character custom label to identify the location of the appliance and to aid in troubleshooting fault conditions.
 3. Individual Appliance Information Display:
 - a. The FACU shall be capable of calling up detailed information for each addressable appliance including the appliance location, status, condition, type of appliance, and configured appliance settings.
 - b. Notification appliances that are not capable of communicating and reporting their individual location, status, condition, type of appliance, and configured appliance settings to the FACU shall not be accepted.
 4. Programmable Appliance Settings:
 - a. The selectable operation of each addressable notification appliance shall be capable of being configured by the FACU without having to replace or remove the appliance from the wall or ceiling.
 - (1) Programmable appliance settings for applicable addressable notification appliances shall include:
 - (a) Operation:
 - General Evac
 - Alert
 - User Defined

- (b) Style:
 - Indoor
 - UL Weatherproof
 - ULC Weatherproof
- (c) Candela Selections:
 - Indoor: 15, 30, 75, 110, 135, or 185 cd (per UL1971)
 - UL Weatherproof: 15 or 75 cd (per UL1971), and 75 or 185 cd (per UL1638)
 - ULC Weatherproof: 20, 30 or 75 cd (per ULCS526)
- (d) Horn Volume:
 - Hi
 - Low
- (e) Horn Cadence:
 - Temporal 3
 - Temporal 4
 - March Time 20 bpm
 - March Time 60 bpm
 - March Time 120 bpm
 - Steady
- (f) Horn Tone:
 - 520 HZ
 - Bell
 - Slow Whoop
 - Siren
 - Hi / Lo
- b. Systems that require replacement or removal of the appliances from the wall or ceiling to change their applicable operation or settings shall not be accepted.
- 5. Programmable Notification Zones:
 - a. Changing the notification zone assigned to a notification appliance shall be configurable by the FACU and shall not require additional circuits or wiring.
 - b. Systems that require additional circuits and wiring to change the notification zone assigned to a notification appliance shall not be accepted.
- 6. Other Emergency and Non-Emergency Notification:
 - a. Where required, notification appliances for purposes not related to fire alarm shall be capable of:
 - (1) Being connected to the same circuit as the fire alarm appliances, and
 - (2) Being individually configured for their intended use without requiring additional circuits or wiring.
 - b. Systems that require separate circuits and wiring for other Emergency and Non-Emergency notification shall not be accepted.
- 7. Addressable Notification Appliance Automated Self-Test:

- a. The fire alarm control unit shall be capable of performing an automated functional self-test of all self-test notification appliances and meet the requirements in NFPA 72, 2013 Edition, 14.2.8 Automated Testing and Table 14.4.3.2 testing requirements.
 - b. Test results for each self-test notification appliance shall be stored in non-volatile memory at the fire alarm control unit.
 - c. The fire alarm control unit shall be capable of running a functional automated test for all self-test notification appliances in a general alarm group or for all self-test appliances within a specific notification zone.
 - d. The duration required to complete the automated functional test for all self-test notification appliances shall be accomplished in 2 minutes or less.
 - e. The automated test results for all self-test notification appliances shall be available from the fire alarm control unit within 4 minutes from the start of the test.
 - f. If any notification appliance fails its automated functional self-test an audible and visual trouble signal shall be annunciated at the fire alarm control unit.
 - (1) The self-test trouble signal shall be a latching trouble signal which requires manual restoration to normal.
8. Addressable Notification Appliance Reports:
- a. The fire alarm control unit shall maintain configuration and test data for each self-test addressable notification appliance.
 - b. The fire alarm control unit shall be capable of generating configuration, self-test, and deficiency reports, that can be viewed through the fire alarm control unit user interface or printed via the fire alarm control unit service port.
 - (1) At minimum, the configuration report shall include the following information applicable for each addressable notification appliance:
 - Point ID
 - Custom Label
 - Device Type
 - Candela Setting
 - (2) At minimum, the self-test report shall include the following information applicable for each self-test notification appliance:
 - Point ID
 - Custom Label
 - Time and Date of last test
 - Pass / Fail results of last visual test
 - Pass / Fail results of last audible test
 - c. The fire alarm control unit shall also be capable of providing a deficiency report that includes a list of all self-test notification appliances that have failed self-test.
9. Magnet test: When the control unit is in diagnostic mode, the appliances shall be capable of being tested with a magnet. The magnet diagnostics shall:
- a. Pulse the appliance LED to indicate appliance address, and
 - b. briefly sound the individual horn to confirm the audible appliance operation, and
 - c. briefly flash the individual strobe to confirm visible appliance operation
 - d. briefly sound the individual speaker to confirm the audible appliance operation

1.6 SUBMITTALS

- A. General: Submit the following according to Conditions of Contract and Division 1 Specification Sections.
 - 1. Product data sheets for system components highlighted to indicate the specific products, features, or functions required to meet this specification. Alternate or as-equal products submitted under this contract must provide a detailed line-by-line comparison of how the submitted product meets, exceeds, or does not comply with this specification.
 - 2. Wiring diagrams from manufacturer.
 - 3. Shop drawings showing system details including location of FACU, all devices, circuiting and details of graphic annunciator.
 - 4. System power and battery charts with performance graphs and voltage drop calculations to assure that the system will operate in accordance with the prescribed backup time periods and under all voltage conditions per UL and NFPA standards.
 - 5. System operation description including method of operation and supervision of each type of circuit and sequence of operations for all manually and automatically initiated system inputs and outputs. A list of all input and output points in the system shall be provided with a label indicating location or use of IDC, SLC, NAC, relay, sensor, and auxiliary control circuits.
 - 6. Operating instructions for FACU.
 - 7. Operation and maintenance data for inclusion in Operating and Maintenance Manual. Include data for each type product, including all features and operating sequences, both automatic and manual. Provide the names, addresses, and telephone numbers of service organizations.
 - 8. Product certification signed by a certified representative of the manufacturer of the fire alarm system components certifying that their products comply with indicated requirements.
 - 9. Record of field tests of system.
- B. Submission to Authority Having Jurisdiction: In addition to routine submission of the above material, make an identical submission to the authority having jurisdiction. Include copies of shop drawings as required to depict component locations to facilitate review. Upon receipt of comments from the Authority, make resubmissions, if required, to make clarifications or revisions to obtain approval.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: A factory authorized installer is to perform the work of this section.
- B. Each and every item of the Fire Alarm System shall be listed under the appropriate category by a Nationally Recognized Testing Laboratory and shall bear the respective "NRTL" label.

1.8 SOFTWARE SERVICE AGREEMENT

- A. Comply with UL 864.
- B. Technical Support: Beginning with Substantial Completion, provide software support for two years.
- C. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
 - 1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

1.9 MAINTENANCE SERVICE

- A. Warranty Maintenance Service: Provide maintenance of fire alarm systems and equipment for a period of 12 months, using factory-authorized service representatives
- B. Basic Services: Routine maintenance visits on an “as needed” basis at times scheduled with the Owner. Respond to service calls within 24 hours of notification of system trouble either by customer visit or other customer contact as necessary. Adjust and replace defective parts and components with original manufacturer's replacement parts, components, and supplies.
- C. Additional Services: Perform services within the above 12-month period not classified as routine maintenance or as warranty work when authorized in writing. Compensation for additional services must be agreed upon in writing prior to performing services.
- D. Maintenance Service Contract: No later than 60 days prior to the expiration of the warranty maintenance services, deliver to the Owner a proposal to provide contract maintenance and repair services for an additional one-year term. As an option with this proposal, deliver to the Owner a proposal to provide scheduled inspection and testing services for a one-year term. Owner will be under no obligation to accept maintenance service contract proposal or inspection and testing proposal.

1.10 EXTRA MATERIALS

- A. General: Furnish extra materials, packaged with protective covering for storage, and identified with labels clearly describing contents as follows:
 - 1. Break Rods for Manual Stations: Furnish quantity equal to 15 percent of the number of manual stations installed; minimum of 6 rods.
 - 2. Notification Appliances: Furnish quantity equal to 10 percent of each type and number of units installed, but not less than one of each type.
 - 3. Smoke Detectors or Sensors, Fire Detectors, and Flame Detectors: Furnish quantity equal to 10 percent of each type and number of units installed but not less than one of each type.
 - 4. Detector or Sensor Bases: Furnish quantity equal to 2 percent of each type and number of units installed but not less than one of each type.

PART 2 – PRODUCTS**2.1 ACCEPTABLE EQUIPMENT AND SERVICE PROVIDERS**

- A. Manufacturers: The equipment and service described in this specification are those supplied and supported by Tyco SimplexGrinnell and represent the base bid for the equipment.
 - 1. Subject to compliance with the requirements of this specification, provide products by one of the following:
 - a. Simplex, a Tyco Company
- B. Being listed as an acceptable Manufacturer in no way relieves obligation to provide all equipment and features in accordance with these specifications.
- C. Alternate products will not be accepted.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

- A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:
 - 1. Manual stations.
 - 2. Heat detectors.
 - 3. Smoke detectors.
 - 4. Duct smoke detectors.

5. Verified automatic alarm operation of smoke detectors.
 6. Automatic sprinkler system water flow.
 7. Fire-extinguishing system operation.
 8. Fire standpipe system.
 - B. Fire-alarm signal shall initiate the following actions:
 1. Continuously operate alarm notification appliances.
 2. Identify alarm at fire-alarm control unit and remote annunciators.
 3. Transmit an alarm signal to the remote alarm receiving station.
 4. Unlock electric door locks in designated egress paths.
 5. Release fire and smoke doors held open by magnetic door holders.
 6. Activate voice/alarm communication system.
 7. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
 8. Close smoke dampers in air ducts of designated air-conditioning duct systems.
 9. Activate emergency shutoffs for gas and fuel supplies.
 10. Record events in the system memory.
 11. Record events by the system printer.
 - C. Supervisory signal initiation shall be by one or more of the following devices and actions:
 1. Valve supervisory switch.
 2. Low-air-pressure switch of a dry-pipe sprinkler system.
 - D. System trouble signal initiation shall be by one or more of the following devices and actions:
 1. Open circuits, shorts, and grounds in designated circuits.
 2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
 3. Loss of primary power at fire-alarm control unit.
 4. Ground or a single break in fire-alarm control unit internal circuits.
 5. Abnormal AC voltage at fire-alarm control unit.
 6. Break in standby battery circuitry.
 7. Failure of battery charging.
 8. Abnormal position of any switch at fire-alarm control unit or annunciator.
 - E. System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire-alarm control unit and remote annunciators. Record the event on system printer where provided.
- 2.3 FIRE ALARM CONTROL UNIT (FACU)
- A. General: Comply with UL 864, "Control Units and Accessories for Fire Alarm Systems".
 - B. The following FACU hardware shall be provided:
 1. Power Limited base panel with platinum cabinet and door, 120 VAC input power.
 2. 2,500 point capacity where (1) point equals (1) monitor (input) or (1) control (output).
 3. 2000 points of annunciation where one (1) point of annunciation equals:
 - a. 1 LED driver output on a graphic driver or 1 switch input on a graphic switch input module.

- b. 1 LED on panel or 1 switch on panel.
4. 9 Amp Power Supply minimum with temperature compensated, dual-rate battery charger capable of charging up to 110 Ah batteries without a separate external battery charger. Battery charger voltage and amperage values shall be accessible on the FACU LCD display.
5. One Auxiliary electronically resettable fused 2A @24VDC Output, with programmable disconnect operation for 4-wire detector reset.
6. One Auxiliary Relay, SPDT 2A @32VDC, programmable as a trouble relay, either as normally energized or de-energized, or as an auxiliary control.
7. Three (3) Class B Addressable Notification Appliance Signaling Line Circuits (SLCs).
 - a. Each Addressable Notification Appliance SLC shall be rated at 3A and capable of supporting up to 127 Notification Appliances per channel.
 - b. Wiring shall be 18 AWG to 12 AWG unshielded twisted pair wire. Systems that require shielded wire for Notification Appliances shall not be accepted.
 - c. A constant voltage under both primary and secondary power conditions shall be maintained at the notification appliance field wiring terminal connections in the FACU to ensure the voltage drop on the circuit is consistent under both primary and secondary power conditions.
 - d. For systems that do not provide a constant voltage source at the FACU notification appliance field wiring terminal connections, the fire alarm contractor shall:
 - (1) Provide separate point-to-point voltage drop calculations for all notification appliances under worst case secondary power specifications, and
 - (2) Perform a complete functional test of all notification appliances under worst case secondary power conditions.
8. Three (3) Class B Notification Appliance Circuits (NAC; rated 3A@24VDC, resistive).
 - a. NAC's shall be conventional reverse polarity operation and shall be for synchronized strobes and independent horn/strobe operation over two wires.
 - b. NACs shall be selectable as auxiliary power outputs derated to 2 A for continuous duty.
 - c. Strobe synchronization and audible cadence synchronization shall be across all panel NAC circuits. Systems that cannot provide listed synchronization across all panel NAC's shall not be acceptable.
9. Where required provide Intelligent Remote Battery Charger for charging up to 50Ah batteries.
10. Expansion Power Supplies with three (3) Class B integral Intelligent Addressable Notification Appliance Signaling Line Circuits (SLCs) for system expansion. Expansion power supplies shall provide complete capability as the primary power supply.
11. Four (4) form "C" Auxiliary Relay Circuits (Form C contacts rated 2A @ 24VDC, resistive), operation is programmable for trouble, alarm, supervisory or other fire response functions. Relays shall be capable of switching up to ½ A @ 120VAC, inductive.
12. The FACU shall support up to (5) RS-232-C ports and one service port. All (5) RS-232 Ports shall be capable of two-way communications.
13. Remote Unit Interface: supervised serial communication channel for control and monitoring of remotely located annunciators and I/O panels.
14. Programmable DACT for per Point Reporting.

15. Fire Panel Internet Interface to provide supplemental notification and remote user access to the FACU using Ethernet and TCP/IP communications protocol compatible with IEEE Standard 802.3.
- C. Cabinet: Lockable steel enclosure. Arrange unit so all operations required for testing or for normal care and maintenance of the system are performed from the front of the enclosure. If more than a single unit is required to form a complete control unit, provide exactly matching modular unit enclosures. Cabinet color shall be platinum.
- D. Alphanumeric Display and System Controls: Panel shall include an 80-character LCD display to indicate alarm, supervisory, and component status messages and shall include a keypad for use in entering and executing control commands.
- E. Distributed Module Operation: FACU shall be capable of allowing remote location of the following modules; interface of such modules shall be through a Style 4 (Class B) supervised serial communications channel (SLC):
 1. Addressable Signaling Line Circuits
 2. Initiating Device Circuits
 3. Notification Appliance Circuits
 4. Auxiliary Control Circuits
 5. Graphic Annunciator LED/Switch Control Modules
 - a. In systems with two or more Annunciators and/or Command Centers, each Annunciator/Command Center shall be programmable to allow multiple Annunciators/Command Centers to have equal operation priority or to allow hierarchal priority control to be assigned to individual Annunciator/Command Center locations.
 6. Amplifiers, voice and telephone control circuits
- F. Voice Alarm: Provide an emergency communication system, integral with the FACU, including voice alarm system components, microphones, amplifiers, and tone generators. Features include:
 1. Amplifiers comply with UL 1711, "Amplifiers for Fire Protective Signaling Systems." Amplifiers shall provide an onboard local mode temporal coded horn tone as a default backup tone. Test switches on the amplifier shall be provided to test and observe amplifier backup switchover. Each amplifier shall communicate to the host panel amplifier and NAC circuit voltage and current levels for display on the user interface. Each amplifier shall be capable of performing constant supervision for non-alarm audio functions such as background music and general paging.
 2. Dual alarm channels permit simultaneous transmission of different announcements to different zones or floors automatically or by use of the central control microphone. All announcements are made over dedicated, supervised communication lines. All risers shall support Class B wiring for each audio channel.
 3. Eight channel digitally multiplexed audio for systems that require more than two channels of simultaneous audio. Up to 8 channels of audio shall be multiplexed on either a style 4 or style 7 twisted pair.
 4. Emergency voice communication audio controller module shall provide up to 32 minutes of message memory for digitally stored messages. Provide supervised connections for master microphone and up to 5 remote microphones.
 5. Status annunciator indicating the status of the various voice alarm speaker zones and the status of fire fighter telephone two-way communication zones.

2.4 ADDRESSABLE INITIATING

A. ADDRESSABLE MANUAL PULL STATIONS

1. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
2. Description: Addressable single- action type, red LEXAN. Station shall mechanically latch upon operation and remain so until manually reset by opening with a key common with the control units. Station shall be pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit. Where double-action stations are provided, the mechanism shall require two actions push top activation door to initiate an alarm.
3. Provide with a front showing red LED showing that will flash each time it is scanned by the Control Unit (once every 4 seconds). In alarm condition, the station LED shall be on steady.
4. Indoor Protective Shield: Where required, or as indicated on the drawings, provide a factory-fabricated, tamperproof, clear LEXAN enclosure shield and red frame that easily fits over manual pull stations which shall be hinged at the top to permit lifting for access to initiate a local alarm. Unit shall be NRTL listed. Lifting the cover shall actuate an integral battery-powered audible horn intended to discourage false-alarm operation. The horn shall be silenced by lowering and realigning the shield. The horn shall provide 85dB at 10 feet and shall be powered by a 9 VDC battery.

B. ADDRESSABLE ANALOG SMOKE SENSORS

1. General Requirements for System Smoke Detectors:
 - a. Comply with UL 268, "Smoke Detectors for Fire Protective Signaling Systems." Include the following features:
 - b. Factory Nameplate: Serial number and type identification.
 - c. Operating Voltage: 24 VDC, nominal and shall be two-wire type.
 - d. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore normal operation.
 - e. Plug-In Arrangement: Sensor and associated electronic components are mounted in a module that connects to a fixed base with a twist-locking plug connection. Base shall provide break-off plastic tab that can be removed to engage the head/base locking mechanism. Provide terminals in the fixed base for connection to building wiring. No special tools shall be required to remove head once it has been locked. Removal of the detector head shall interrupt the supervisory circuit of the fire alarm detection loop and cause a trouble signal at the control unit. Sensors shall include a communication transmitter and receiver in the mounting base having a unique identification and capability for status reporting to the FACU. Sensor address shall be located in base to eliminate false addressing when replacing sensors. Integral Addressable Module shall be arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit. Each sensor base shall contain an integral visual-indicating LED that wi
 - f. Each sensor base shall contain a magnetically actuated test switch to provide for easy pre-certification alarm testing at the sensor location.
 - g. Each sensor shall be scanned by the Control Unit for its type identification to prevent inadvertent substitution of another sensor type. Upon detection of a "wrong device", the control unit shall operate with the installed device at the default alarm settings for that

sensor; 2.5% obscuration for photoelectric sensor, 135-deg F and 15-deg F rate-of-rise for the heat sensor, but shall indicate a "Wrong Device" trouble condition.

- h. Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit. Provide multiple levels of detection sensitivity for each sensor.
 - i. Environmental compensation, programmable sensitivity settings, status testing, and monitoring of sensor dirt accumulation for the duct smoke sensor shall be provided by the FACU.
 - j. The sensor's electronics shall be immune from nuisance alarms caused by EMI and RFI. Removal of the sensor head for cleaning shall not require the setting of addresses.
 - k. Bases: CO Sensor, relay output, sounder and isolator bases shall be supported alternatives to the standard base.
2. Addressable Sensor Bases
- a. Standard base - Twist lock addressable base with address selection DIP switch accessible from front with sensor removed. Integral red LED for power-on (pulsing), or alarm or trouble (steady on). Locking anti-tamper design mounts on standard outlet box.
 - b. Sensor Base with remote device connection - All standard base features with wired connection for either a Remote LED alarm indicator or remote relay (relay is unsupervised and requires separate 24VDC)
 - c. Supervised Relay Bases - All standard base features and shall be available in either a 4-Wire Sensor Base to use with remote or locally mounted relay; requires separate 24 VDC, or as a 2-Wire Sensor Base to use with remote or locally mounted relay; no separate power required. Supervised relay operation shall be programmable and shall be manually operated from control panel.
 - d. Sensor base with built-in electronic alarm sounder - All standard base features and piezoelectric sounder shall provide high output (88 dBA) with low current requirements (20 mA). Sounder shall be synchronized via SLC communications or by the NAC if NAC powered, sounder shall operation shall be programmable and shall be manually operated from control panel.
 - e. 520 Hz Sensor base with built-in electronic low frequency sounder - All standard base features and piezoelectric sounder shall provide a low frequency 520 Hz Square Wave (85 dBA) with nominal current requirements (115 mA). Sounder shall be synchronized via SLC communications or by the NAC if NAC powered, sounder operation shall be programmable and shall be manually operated from control panel.
 - (1) Emitted tone shall be a 520Hz Square Wave signal in compliance with the requirements of the 2010 edition of NFPA 72 for sleeping areas.
 - (2) The 520Hz Sounder base shall be listed to UL 268 and UL464, Audible Signal Appliances.

C. ADDRESSABLE DUCT SMOKE SENSOR

- 1. Standard Addressable Duct Smoke Sensor Unit. Photoelectric type, with sampling tube of design and dimensions as recommended by the manufacturer for the specific duct size and installation conditions where applied. Duct housing shall include relay or relay driver as required for fan shutdown.

- a. Environmental compensation, programmable sensitivity settings, status testing, and monitoring of sensor dirt accumulation for the duct smoke sensor shall be provided by the FACU.
 - b. The Duct Housing shall provide a supervised relay driver circuit for driving up to 15 relays with a single "Form C" contact rated at 7A@ 28VDC or 10A@ 120VAC. This auxiliary relay output shall be fully programmable independent of the sensor head for activation by other alarm initiating devices within the fire alarm system. Relay shall be mounted within 3 feet of HVAC control circuit.
 - c. Duct Housing shall provide a magnetic test area and Red sensor status LED and Duct Housing shall provide a relay control Yellow LED trouble indicator.
 - d. Duct Housing shall have a transparent cover to monitor for the presence of smoke. Cover shall secure to housing by means of four (4) captive fastening screws.
 - e. Duct Housing shall provide two (2) Test Ports for measuring airflow and for testing. These ports will allow aerosol injection in order to test the activation of the duct smoke sensor.
 - f. For maintenance purposes, it shall be possible to clean the duct housing sampling tubes by accessing them through the duct housing front cover.
 - g. Each duct smoke sensor shall be provided with a Remote Test Station with an alarm LED and test switch.
 - h. Where indicated provide a NEMA 4X weatherproof duct housing enclosure that shall provide for the circulation of conditioned air around the internally mounted addressable duct sensor housing to maintain the sensor housing at its rated temperature range. The housing shall be UL Listed to Standard 268A.
- D. ADDRESSABLE HEAT SENSORS
1. General Requirements for Heat Detectors: Comply with UL 521.
 2. Thermal Sensor Combination type: Fixed-temperature and rate-of-rise unit with plug-in base and alarm indication lamp; Actuated by either a fixed temperature of 135 deg F (57 deg C) or a rate of rise that exceeds 15 deg F (8 deg C) per minute unless otherwise indicated.
 3. Thermal sensor shall be of the epoxy encapsulated electronic design. It shall be thermistor-based, rate-compensated, self-restoring and shall not be affected by thermal lag. Selectable rate compensated, fixed temperature sensing with or without rate-of-rise operation.
 4. Mounting: Twist-lock base interchangeable with smoke-sensor heads.
 5. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
 6. Sensor fixed temperature sensing shall be independent of rate-of-rise sensing and programmable to operate at 135-deg F or 155-deg F. Sensor rate-of-rise temperature detection shall be selectable at the FACU for either 15-deg F or 20-deg F per minute.
 7. Sensor shall have the capability to be programmed as a utility monitoring device to monitor for temperature extremes in the range from 32-deg F to 155-deg F.
 8. Unless otherwise indicated, sensors shall be analog-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for temperature by fire-alarm control unit.
 - a. Rate-of-rise temperature characteristic shall be selectable at fire-alarm control unit for 15 or 20 deg F (8 or 11 deg C) per minute.

- b. Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F (57 or 68 deg C).
- E. ADDRESSABLE CO SENSOR
 - 1. Addressable CO Sensor
 - a. The CO Sensor shall be an addressable carbon monoxide (CO) sensing module providing both CO toxic gas detection and enhanced fire detection, and shall be listed to UL 268, Smoke Detectors for Fire Alarm Signaling Systems and UL 2075, Gas and Vapor Detectors and Sensors; allowing systems to be listed to UL 2034, Single and Multiple Station Carbon Monoxide Alarms.
 - b. The CO Sensor shall include CO sensor element mounted in the sensor base which can be easily replaced without replacing the complete sensor base assembly.
 - c. The CO Sensor base shall provide address selection in the base allowing the address to remain with its location when the sensor is removed for service or type change.
 - d. The CO Sensor base shall include an integral red LED to indicate the power-on, trouble, test mode or alarm status.
 - e. CO sensor shall provide enhanced fire detection with the addition of two selectable modes of operation: Nuisance Alarm Reduction Mode and Faster Fire Detection.
 - f. The CO Sensor shall provide a 10-year life expectancy before replacement is necessary or required.
 - g. The CO Sensor base shall report the following CO Sensor troubles: Communication loss, Disabled, Almost Expired 12 Months, Almost Expired 6 Months, Expired (End of Life), and Sensor Missing/Failed.
- F. ADDRESSABLE CIRCUIT INTERFACE MODULES
 - 1. Addressable Circuit Interface Modules: Arrange to monitor or control one or more system components that are not otherwise equipped for addressable communication. Modules shall be used for monitoring of waterflow, valve tamper, non-addressable devices, and for control of AHU systems.
 - 2. Addressable Circuit Interface Modules will be capable of mounting in a standard electric outlet box. Modules will include cover plates to allow surface or flush mounting. Modules will receive their operating power from the signaling line circuit or a separate two wire pair running from an appropriate power supply, as required.
 - 3. There shall be the following types of modules:
 - a. Type 1: Monitor Circuit Interface Module:
 - (1) For conventional 2-wire smoke detector and/or contact device monitoring with Class B or Class A wiring supervision. The supervision of the zone wiring will be Class B. This module will communicate status (normal, alarm, trouble) to the FACU.
 - (2) For conventional 4-wire smoke detector with Class B wiring supervision. The module will provide detector reset capability and over-current power protection for the 4-wire detector. This module will communicate status (normal, alarm, trouble) to the FACU.
 - b. Type 2: Line Powered Monitor Circuit Interface Module
 - (1) This type of module is an individually addressable module that has both its power and its communications supplied by the two wire signaling line circuit. It provides location specific addressability to an initiating device by monitoring normally open dry contacts. This module shall have the capability of communicating four zone

status conditions (normal, alarm, current limited, trouble) to the FACU.

- (2) This module shall provide location specific addressability for up to five initiating devices by monitoring normally closed or normally open dry contact security devices. The module shall communicate four zone status conditions (open, normal, abnormal, and short). The two-wire signaling line circuit shall supply power and communications to the module.

c. Type 3: Single Address Multi-Point Interface Modules

- (1) This multipoint module shall provide location specific addressability for four initiating circuits and control two output relays from a single address. Inputs shall provide supervised monitoring of normally open, dry contacts and be capable of communicating four zone status conditions (normal, open, current limited, and short). The input circuits and output relay operation shall be controlled independently and disabled separately.
- (2) This dual point module shall provide a supervised multi-state input and a relay output, using a single address. The input shall provide supervised monitoring of two normally open, dry contacts with a single point and be capable of communicating four zone status conditions (normal, open, current limited, and short). The two-wire signaling line circuit shall supply power and communications to the module.
- (3) This dual point module shall monitor an unsupervised normally open, dry contact with one point and control an output relay with the other point, using a single address. The two-wire signaling line circuit shall supply power and communications to the module.

d. Type 4: Line Powered Control Circuit Interface Module

- (1) This module shall provide control and status tracking of a Form "C" contact. The two-wire signaling line circuit shall supply power and communications to the module.

e. Type 5: 4-20 mA Analog Monitor Circuit Interface Module

- (1) This module shall communicate the status of a compatible 4-20 mA sensor to the FACU. The FACU shall annunciate up to three threshold levels, each with custom action message; display and archive actual sensor analog levels; and permit sensor calibration date recording.

4. All Circuit Interface Modules shall be supervised and uniquely identified by the control unit. Module identification shall be transmitted to the control unit for processing according to the program instructions. Modules shall have an on-board LED to provide an indication that the module is powered and communicating with the FACU. The LEDs shall provide a troubleshooting aid since the LED blinks on poll whenever the peripheral is powered and communicating.

2.5 ADDRESSABLE NOTIFICATION

A. ADDRESSABLE ALARM NOTIFICATION APPLIANCES

1. Addressable Notification Appliances: The Contractor shall furnish and install Addressable Notification Appliances and accessories to operate on compatible signaling line circuits (SLC).
 - a. Addressable Notification appliance operation shall provide power, supervision and separate control of horns and strobes over a single pair of wires. The controlling channel (SLC) digitally communicates with each appliance and receives a response to verify the appliance's presence on the channel. The channel provides a digital command to control

- appliance operation. SLC channel wiring shall be unshielded twisted pair (UTP), with a capacitance rating of less than 60pf/ft and a minimum 3 twists (turns) per foot.
- b. All Notification Appliances shall operate as a completely independent device allowing for specific location alerting of both fire alarm and Mass Notification functions. Each visible device (both clear fire alarm and amber mass notification) shall be capable of operating on multiple notification zones or completely separate from all other notification devices, this allows "On the fly" program operation changes for Mass Notification alerting and fire alarm notification.
 - c. All Notification Appliances shall operate as a completely independent device allowing for appliances in handicap accessible rooms and other locations to operate on the same SLC and to activate individually based on an alarm condition in a room or as part of a general alarm condition where all appliances activate together.
 - d. Individual Notification Appliances shall be able to be grouped into zones (or operational groups) by central programming at the main fire alarm control unit.
 - e. Notification Appliances shall provide for "unobtrusive" testing. Each Notification Appliance shall be tested for audible and visible operation on an individual basis at the device or from the main fire alarm control unit, allowing for minimal invasive impact.
 - f. Class B (Style 4) notification appliances shall be wired without requiring traditional in/out wiring methods; addressable "T" Tapping shall be permitted. Up to 127 addresses can be supported on a single channel.
 - g. Each Addressable notification appliance shall contain an electronic module and a selectable address setting to allow it to occupy a unique location on the channel. This on-board module shall also allow the channel to perform appliance diagnostics that assist with installation and subsequent test operations. A visible LED on each appliance shall provide verification of communications and shall flash with the appliances address setting when locally requested using a magnetic test tool.
 - h. Each addressable notification appliance shall have electrical test point access without removing the device cover.
 - i. Both wall mount and ceiling mount devices shall be available.
2. Addressable Visible/Only: Addressable strobe shall be listed to UL 1971. The V/O device shall consist of a xenon flash tube and associated lens/reflector system, cover and mounting plate. For ease of installation the mounting plate shall mount directly to standard single gang, double gang or 4" square electrical box, without the use of special adapters or trim rings. When the appliance is connected to an active circuit, the front cover of the appliance shall be removable without causing a trouble indication on the fire alarm control unit. Appliances shall be wired with UTP conductors, having a minimum of 3 twists per foot. The V/O appliance shall be provided with multiple minimum flash intensities of 15cd, 30cd, 75cd, 110cd, 135cd and 185cd. The Candela levels shall be settable from the fire alarm control unit or by using a hardware selector on the appliance.
 3. Standard Speaker: Speaker notification appliances shall be listed to UL 1480.
 - a. The speaker shall operate on a standard 25VRMS or 70.7VRMS NAC using twisted / shielded wire.
 - b. The following taps are available: 0.25W, 0.50W, 1.0W and 2.0W. At the 1.0W tap, the speaker has minimum UL rated sound pressure level of 84dBA at 10 feet.
 - c. The speaker shall have a frequency response of 400 to 4000 Hz for Fire Alarm and 125 to 12kHz for general signaling.

- d. The speaker shall install directly to a 4" square, 1 ½" deep electrical box with 1 ½" extension.
- 4. Hybrid Speaker/Visible: Combination Speaker/Visible (S/V) units combine the speaker and visible functions into a common housing. The S/V shall be listed to UL 1971 and UL 1480. Addressable functionality controls visible operation, while the speaker operates on a 25VRMS or 70.7VRMS NAC.
 - a. Twisted/shielded wire is required for speaker connections on a standard 25VRMS or 70.7VRMS NAC and UTP conductors, having a minimum of 3 twists per foot is required for addressable strobe connections.
 - b. The following taps are available: 0.25W, 0.50W, 1.0W and 2.0W. At the 1.0W tap, the speaker has minimum UL rated sound pressure level of 82 dBA at 10 feet.
 - c. The S/V shall have a frequency response of 400 to 4000 Hz for Fire Alarm and 125 to 12kHz for general signaling.
 - d. The S/V installs directly to a 4" square, 1 ½" deep electrical box with 1 ½" extension.
- 5. Addressable Speaker: Addressable Speaker notification appliances shall be listed to UL 1480. Individual device level supervision and activation control shall be provided by the fire alarm control unit.
 - a. Speakers shall be individually powered, addressed, and controlled from a compatible fire alarm control unit Signaling Line Circuit (SLC) using Unshielded Twisted Pair (UTP) cable and T-taps shall be allowed for Class B installation reducing wiring costs and wiring distances. Shielded cable shall not be required.
 - b. Speakers shall provide for Fire Alarm and General Signaling functionality in a single unit, eliminating additional devices. Device "Self-Test" shall be supported by a compatible fire alarm control unit and shall be UL listed and NFPA 72 compliant. Speakers shall be UL listed to provide a 520Hz audio tone in compliance with NFPA 72 for sleeping areas.
 - c. The speaker audio shall be provided by a standard 25VRMS or 70.7VRMS audio circuit using Unshielded Twisted Pair (UTP) cable and T-taps shall be allowed for Class B installation reducing wiring costs and wiring distances. Supervision of this circuit shall be provided by the addressable speaker. Shielded cable shall not be required.
 - d. Speaker power taps shall be at a minimum of 0.25W, 0.50W, 1.0W and 2.0W. At the 1.0W tap, the speaker shall have a minimum UL rated sound pressure level of 86dBA at 10 feet for the Standard Output version and 84dBA at 10 feet for the High-Fidelity version.
 - e. Speakers shall be available in either "Standard Output" with a minimum frequency response of 400 to 4000 Hz or in "High Fidelity Output" with a minimum frequency response of 200 to 10,000 Hz. Standard Output speakers shall use a multi-tapped speaker for audio/tone notification.
 - f. Wall mount appliances shall be available in Red and ceiling mount appliances shall be White. Labeling shall be available as either "FIRE", "ALERT" or no labeling.
 - g. The speaker shall install directly to a 4" square, 2 1/8" deep electrical box. Extensions for these boxes shall not be required. Units shall be modular in design to allow for easy installation and for easy changing of device color and labeling.
- 6. Addressable Speaker/Visible: Combination Speaker/Visible (S/V) units combine the speaker and visible functions into a common housing. The S/V shall be listed to UL 1971 and UL

1480. Addressable functionality controls visible operation, while the speaker shall operate on a 25VRMS or 70.7VRMS NAC.
- a. Operational functions and features of Addressable Speaker above shall apply to this section. Operational functions and features of Addressable Strobe above shall apply to this section.
 - b. Wall mount appliances shall be available Red and ceiling mount appliances shall be White. Labeling shall be available as either "FIRE", "ALERT" or no labeling.
 - c. The speaker shall install directly to a 4" square, 2 1/8" deep electrical box. Extensions for these boxes shall not be required. Units shall be modular in design to allow for easy installation and for easy changing of device color and labeling
7. Isolator Module: Isolator module provides short circuit isolation for addressable notification appliance SLC wiring. Isolator shall be listed to UL 864. The Isolator shall mount directly to a minimum 2 1/8" deep, standard 4" square electrical box, without the use of special adapter or trim rings. Power and communications shall be supplied by the Addressable Controller channel SLC; dual port design shall accept communications and power from either port and shall automatically isolate one port from the other when a short circuit occurs. The following functionality shall be included in the Isolator module:
- a. Report faults to the host FACU.
 - b. On-board Yellow LED provides module status.
 - c. After the wiring fault is repaired, the Isolator modules shall test the lines and automatically restore the connection.
- 2.6 FIRE FIGHTERS' TELEPHONES
- A. Telephone Hand Sets: High-impact plastic handset, heavy-duty coil cord, and hook switch; connected to the FACU by means of dedicated, supervised communication lines. Handsets have a dynamic receiver and a carbon transmitter, operating on 24VDC.
 - B. A black master telephone handset with a push to talk button and a flexible-coiled self-winding five (5) foot cord shall be provided and recessed within a protective unit-mounted enclosure at the command center.
 - C. Cabinet: Flush- or surface-mounted as indicated, 18-gage, minimum, painted steel with a latched hinged door with trim labeled "Fire Fighters' Phone." Size to accommodate handset and cord.
- 2.7 MAGNETIC DOOR HOLDERS
- A. Furnished by others. This contractor shall include wiring, all final connections, and installation for all units indicated on plans.
- 2.8 REMOTE LCD ANNUNCIATOR
- A. Provide a remote LCD Annunciator, where required, with the same "look and feel" as the FACU operator interface. The Remote LCD Annunciator shall use the same Primary Acknowledge, Silence, and Reset Keys; Status LEDs and LCD Display as the FACU.
 - B. Annunciator shall have super-twist LCD display with two lines of 40 characters each. Annunciator shall be provided with four (4) programmable control switches and associated LEDs.
 - C. Under normal conditions the LCD shall display a "SYSTEM IS NORMAL" message and the current time and date.
 - D. Should an abnormal condition be detected the appropriate LED (Alarm, Supervisory or Trouble) shall flash. The unit audible signal shall pulse for alarm conditions and sound steady for trouble and supervisory conditions.

- E. The LCD shall display the following information relative to the abnormal condition of a point in the system:
 - 1. 40-character custom location label.
 - 2. Type of device (e.g., smoke, pull station, waterflow).
 - 3. Point status (e.g., alarm, trouble).
- F. Operator keys shall be key switch enabled to prevent unauthorized use. The key shall only be removable in the disabled position. Acknowledge, Silence and Reset operation shall be the same as the FACU.

2.9 DIGITAL ALARM COMMUNICATOR TRANSMITTER

- A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632 and be listed and labeled by an NRTL.
- B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture two telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.
- C. Local functions and display at the digital alarm communicator transmitter shall include the following:
 - 1. Verification that both telephone lines are available.
 - 2. Programming device.
 - 3. LED display.
 - 4. Manual test report function and manual transmission clear indication.
 - 5. Communications failure with the central station or fire-alarm control unit.
- D. Digital data transmission shall include the following:
 - 1. Address of the alarm-initiating device.
 - 2. Address of the supervisory signal.
 - 3. Address or loss of power.
 - 4. Low battery.
 - 5. Abnormal test signal.
 - 6. Communication bus failure.
- E. Secondary Power: Integral rechargeable battery and automatic charger.
- F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.10 EMERGENCY POWER SUPPLY

- A. General: Components include battery, charger, and an automatic transfer switch.
- B. Battery: Sealed lead-acid or nickel cadmium type. Provide sufficient capacity to operate the complete alarm system in normal or supervisory (non-alarm) mode for a period of 24 hours. Following this period of operation on battery power, the battery shall have sufficient capacity to operate all components of the system, including all alarm notification devices in alarm mode for a period of 15 minutes.

2.11 DEVICE GUARDS

- A. Provide monitor module for connection to the fire alarm system signaling line circuit.

PART 3 – EXECUTION

3.1 INSTALLATION, GENERAL

- A. Install system components and all associated devices in accordance with applicable NFPA Standards and manufacturer's recommendations.
- B. Installation personnel shall be supervised by persons who are qualified and experienced in the installation, inspection, and testing of fire alarm systems. Examples of qualified personnel shall include, but not be limited to, the following:
 - 1. Factory trained and certified personnel.
 - 2. National Institute of Certification in Engineering Technologies (NICET) fire alarm level II certified personnel.
 - 3. Personnel licensed or certified by state or local authority.

3.2 EQUIPMENT INSTALLATION

- A. Furnish and install a complete Fire Alarm System as described herein and as shown on the plans. Include sufficient control unit(s), annunciator(s), manual stations, automatic fire detectors, smoke detectors, audible and visible notification appliances, wiring, terminations, electrical boxes, Ethernet drops, and all other necessary material for a complete operating system.
- B. Water-Flow and Valve Supervisory Switches: Connect for each sprinkler valve required to be supervised.
- C. Device Location-Indicating Lights: Locate in the public space immediately adjacent to the device they monitor.
- D. Install manual station with operating handle 48 inches (1.22 m) above floor. Install wall mounted audible and visual notification appliances not less than 80 inches (2.03 m) above floor to bottom of lens and not greater than 96 inches (2.44 m) above floor to bottom of lens.
- E. Mount outlet box for electric door holder to withstand 80 pounds pulling force.
- F. Make conduit and wiring connections to door release devices, sprinkler flow switches, sprinkler valve tamper switches, fire suppression system control units, duct smoke detectors.
- G. Automatic Detector Installation: Conform to NFPA 72.
- H. Ethernet Drop: A standard RJ-45 Ethernet connection to the owner's Ethernet network shall be provided at each fire alarm control unit as part of the contract.

3.3 PREPARATION

- A. Coordinate work of this Section with other affected work and construction schedule.

3.4 CONNECTIONS

- A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Division 08 Section "Door Hardware." Connect hardware and devices to fire-alarm system.
 - 1. Verify that hardware and devices are NRTL listed for use with fire-alarm system in this Section before making connections.
- B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 3 feet (1 m) from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

1. Alarm-initiating connection to smoke-control system (smoke management) at firefighter smoke-control system panel.
2. Alarm-initiating connection to stairwell and elevator-shaft pressurization systems.
3. Smoke dampers in air ducts of designated air-conditioning duct systems.
4. Alarm-initiating connection to elevator recall system and components.
5. Alarm-initiating connection to activate emergency lighting control.
6. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
7. Supervisory connections at valve supervisory switches.
8. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
9. Supervisory connections at elevator shunt trip breaker.
10. Supervisory connections at fire-pump power failure including a dead-phase or phase-reversal condition.
11. Supervisory connections at fire-pump engine control panel.

3.5 WIRING INSTALLATION

- A. System Wiring: Wire and cable shall be a type listed for its intended use by an approval agency acceptable to the Authority Having Jurisdiction and shall be installed in accordance with the appropriate articles from the current approved edition of NFPA 70: National Electric Code (NEC).
- B. Contractor shall obtain from the Fire Alarm System Manufacturer written instruction regarding the appropriate wire/cable to be used for this installation. No deviation from the written instruction shall be made by the Contractor without the prior written approval of the Fire Alarm System Manufacturer.
- C. Color Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color code for alarm initiating device circuits wiring and a different color code for supervisory circuits. Color-code notification appliance circuits differently from alarm-initiating circuits. Paint fire alarm system junction boxes and covers red.
- D. Ethernet Circuits:
 1. Ethernet circuits shall be provided to the Fire Alarm Control Unit as shown on the plans.
 2. Where a dedicated Fire Alarm Ethernet LAN is specified only Agency Listed Fire Alarm Ethernet hardware shall be installed.
 3. The electrical contractor shall coordinate and ensure proper Ethernet connections occur at the fire alarm control unit and other designated equipment locations prior to system turnover.

3.6 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- B. Install framed instructions in a location visible from fire-alarm control unit.

3.7 GROUNDING

- A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

3.8 FIELD QUALITY CONTROL

- A. Manufacturer's Field Services: Provide services of a factory-authorized service representative to supervise the field assembly and connection of components and the pretesting, testing, and adjustment of the system.

- B. Service personnel shall be qualified and experienced in the inspection, testing, and maintenance of fire alarm systems. Examples of qualified personnel shall be permitted to include, but shall not be limited to, individuals with the following qualifications:
 - 1. Factory trained and certified.
 - 2. National Institute for Certification in Engineering Technologies (NICET) fire alarm certified.
 - C. Pretesting: Determine, through pretesting, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new and retest until satisfactory performance and conditions are achieved.
 - D. Inspection:
 - 1. Inspect equipment installation, interconnection with system devices, mounting locations, and mounting methods.
 - 2. Verify that units and controls are properly installed, connected, and labeled and that interconnecting wires and terminals are identified.
 - E. Acceptance Operational Tests:
 - 1. Perform operational system tests to verify conformance with specifications:
 - a. Each alarm initiating device installed shall be operationally tested. Each device shall be tested for alarm and trouble conditions. Contractor shall submit a written certification that the Fire Alarm System installation is complete including all punch-list items. Test battery operated emergency power supply. Test emergency power supply to minimum durations specified. Test Supervising Station Signal Transmitter. Coordinate testing with Supervising Station monitoring firm/entity.
 - b. Test each Notification Appliance installed for proper operation. Submit written report indicating sound pressure levels at specified distances.
 - c. Test Fire Alarm Control Unit and Remote Annunciator.
 - 2. Provide minimum 10 days notice of acceptance test performance schedule to Owner, and local Authority Having Jurisdiction.
 - F. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets the Specifications and complies with applicable standards.
 - G. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log. Use NFPA 72 Forms for documentation.
 - H. Final Test, Record of Completion, and Certificate of Occupancy:
 - 1. Test the system as required by the Authority Having Jurisdiction in order to obtain a certificate of occupancy. Provide completed NFPA 72 Record of Completion form to Owner and AHJ.
- 3.9 DEMONSTRATION
- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.
- 3.10 CLEANING AND ADJUSTING
- A. Cleaning: Remove paint splatters and other spots, dirt, and debris. Clean unit internally using methods and materials recommended by manufacturer.
 - B. Occupancy Adjustments: When requested within one year of date of Substantial Completion, provide on-site assistance in adjusting sound pressure levels and adjusting controls and

sensitivities to suit actual occupied conditions. Provide up to three visits to the site for this purpose.

3.11 TRAINING

- A. Provide the services of a factory-authorized service representative to demonstrate the system and train Owner's maintenance personnel as specified below.
 - 1. Train Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventive maintaining of the system. Provide a minimum of 2 hours' training.
 - 2. Schedule training with the Owner at least seven days in advance.

3.12 AS BUILT DRAWINGS, TESTING, and MAINTENANCE INSTRUCTIONS

A. As Built Drawings

A complete set of reproducible "as-built" drawings showing installed wiring, specific interconnections between all equipment, and internal wiring of the equipment shall be delivered to the owner upon completion of system.

B. Operating and Instruction Manuals

Three (3) complete sets of operating and instruction manuals, each placed in a 3-ring binder, shall be delivered to the owner upon completion. Each manual shall contain a copy of the as-built fire alarm system drawings. The instruction period for the owner or its representatives shall be 4 hours, performed during normal business hours.

C. Testing Frequency Instructions

- 1. Complete, accurate, step-by-step testing instructions giving recommended and required testing frequency of all equipment, methods for testing each individual piece of equipment, and a complete trouble-shooting manual explaining how to test the primary internal parts of each piece of equipment shall be delivered to the owner upon completion of the system.
- 2. Maintenance instructions shall be complete, easy to read, understandable, and shall provide the following information:
 - Instruction on replacing any components of the system, including internal parts.
 - Instructions on periodic cleaning and adjustment of equipment with a schedule of these functions.

A complete list of all equipment and components with information as to the address and phone number of both the manufacturer and local supplier of each item.

- 3. User operating instructions shall be provided, and prominently displayed on the cabinet front or on a separate sheet located next to the fire alarm control unit, in accordance with UL Standard #864.

END OF SECTION

SECTION 28 07 24 AREA RESCUE SYSTEM

PART 1 – GENERAL

1.1 GENERAL

- A. The Electrical Contractor shall furnish and install all outlet boxes and conduit (with pull strings). Simplex Grinell shall furnish and install all wiring, telephones, annunciators and speakers as shown on the plans, and all other equipment necessary to provide a complete and operating Area of Rescue system. All equipment shall comply with ADA Code 4.3.11.4.
- B. Equipment supplied by Simplex Grinell shall be considered as meeting these specifications and as the base bid.

1.2 ACCEPTABLE MANUFACTURERS

Simplex-Grinell
Rath System

1.3 SUBMITTALS

- A. Data sheets shall be provided on all equipment being provided.
- B. Internal control cabinet drawings showing internal block diagram connections shall be provided.
- C. Wiring diagrams showing typical field wiring connections shall be provided.
- D. FCC registration number and certificate shall be provided.

1.4 QUALIFICATIONS

- A. The Contractor shall be from an established and locally run business which has been operating in the area for a minimum of five years.
- B. The Contractor shall show evidence that he maintains a service organization and parts inventory to adequately support the supplied equipment.

1.5 MAINTENANCE SERVICE

- A. The Contractor shall provide a one-year guarantee of the installed system against defects in material and workmanship. All labor and materials shall be provided at no expense to the Owner. Guarantee period shall begin on the date of acceptance by the Owner or engineer.
- B. A maintenance contract offering continued factory authorized service of this system shall be made available if requested by the Owner.

1.6 QUALITY ASSURANCE

- A. The Contractor shall currently maintain a locally run business for a minimum of five years and shall be an authorized distributor of the supplied equipment with full warranty privileges.
- B. The Contractor shall maintain at his facility the necessary spare parts in the proper proportion as recommended by the equipment manufacturer to maintain and service the equipment being supplied. This facility shall be available for inspection by the engineer.
- C. The supplying Contractor shall have attended the manufacturer's installation and service school.
- D. The Contractor shall furnish manufacturer's manuals of the completed system including individual specification sheets, schematics, inter-panel and intra-panel wiring diagrams. In addition, all information necessary for the proper operation of the system must be included. Any bidder using other than the specified equipment must provide this information prior to bidding.
- E. As built drawings that include any changes to wiring, wiring designations, junction box labeling and any other pertinent information shall be supplied upon completion of project.

1.7 IN SERVICE TRAINING

- A. The Contractor shall furnish training with the system. These sessions shall be broken into segments that will facilitate the training of individuals in operating Master Telephone equipment as well as call station panels. Operating manuals and users guides shall be provided at the time of the training.

1.8 WIRING

- A. System wiring shall be CAT III, 22 AWG, UL Listed Cable. Wiring shall meet all established state and local electrical codes. All wiring shall test free from opens, grounds and shorts.
- B. This contractor to provide one (1) CAT 6 cable from the master station to the MDF room for interconnect to phone system. Provide all required material, labor, and final connections as required.

1.9 BASIC SYSTEM OPERATION

- A. When the system is in normal operating mode, the Master Telephone Display shall indicate time and date. When operated, the system shall provide two way visual and audible communication between a Master location and Area of Rescue stations.
- B. When an Emergency call is placed by an Area of Rescue station the Master Telephone shall ring and the display shall indicate the number of the calling station, along with the priority of the call. All Area of Rescue stations shall be displayed at an Emergency level. Provide a wall display is provided it shall display the call in red lettering. Communications is established by simply answering the Master Telephone. When communications is completed and the Master Telephone has been hung up, the display will continue to show the station number until the station has been reset (See Paragraph 1.9.C)
- C. When an Emergency call is placed by an Area of Rescue station several indications must be provided at the station to assure the caller that the call is being processed. After pressing the call button the caller will be provided with both a visual and audible confirmation. A call placed LED shall begin to flash rapidly and a short tone shall be generated over the speaker. When the call has been answered by the Master Telephone the LED shall flash at a slower rate and a connection tone shall be heard through the speaker. To eliminate confusion this tone shall be different than the confirmation tone. Full two-way voice communication shall be provided without the need of any push to talk switches. The caller simply talks in the direction of the intercom speaker. Upon completion of the call, the LED shall remain on steady providing visual indication that help is coming. The LED will not be turned off until building personnel have reported to the Area of Rescue. A reset is necessary at the station to turn the LED off and remove the call from the Master Telephone's display queue. This is accomplished by a momentary rocker type pushbutton on the station.

PART 2 – PRODUCTS

- 2.1 The installation shall include a comprehensive programmable microprocessor-based Area of Rescue communications system consisting of a central switching exchange capable of handling up to 48 Area of Rescue stations. The system shall be equipped for 6 stations.
- 2.2 All programmable functions shall be located in battery backed ram to prevent loss in a power failure condition.
- 2.3 System shall have provisions for battery back-up and charger specifically designed for use with system power supplies. Systems that use a uninterruptable AC power supply (UPS) system shall not be accepted.
- 2.4 The central switch shall utilize standard dual tone multi-frequency type decoding (DTMF) for interconnection with standard telephone systems.

- 2.5 The central switch shall provide an RS-232 port for connection of a call logging printer.
- 2.6 Provide an individual one (1) watt amplifier circuit for each Area of Rescue station to allow absolute flexibility and redundancy for emergency paging. Equipment requiring a single power amp for these functions shall size such an amplifier as to deliver a minimum of 1.5 watts per station to compensate for inherent transformer losses.
- 2.7 The system shall be provided with four (4) multifunction ports for Master Telephones and or connection to a loop start trunk port of a KEY or PBX telephone system. All communication between Master Telephones shall be non-blocking.
- 2.8 Incoming calls from any Area of Rescue station location may be directed to any of four (4) multifunction ports. It may also be possible to redirect these calls to a secondary Master Telephone or KSU/PBX system if there is no answer at the primary station.
- 2.9 The system shall be provided with voice synthesized call-in, providing the four multifunction ports with audible annunciation of the calling stations number. This enables the buildings telephone system to receive station identification numbers directly through the handset.
- 2.10 Nine (9) built in software definable signaling tones.
- 2.11 Two (2), three (3) or four (4) digit programmable Area of Rescue station numbers for individual station identification.
- 2.12 Eight (8) internal relays which can be activated manually from any Master Telephone or automatically by the CPU when Emergency conditions occur.
- 2.13 Caller I.D. information shall be provided at each of the four (4) ports for interfacing with a building PBX.
- 2.14 A call confirmation tone to the Area of Rescue station will be generated from the CPU to the station when a call is placed. This tone verifies to the caller that the call has been received by the CPU.
- 2.15 Dual chime pre-announce tone shall be generated to the station when the Master Telephone has answered and communications has been established.
- 2.16 Unanswered calls from ADA stations shall, after a user determined time, have their station I.D. number automatically announced over any one or group of system speakers or through the buildings paging system. This automatic page notifies key building personnel of an unanswered emergency condition.
- 2.17 The Master Telephone Station shall include the following:
 - A. A standard DTMF dialing instrument for voice communications with Area of Rescue stations. The instrument shall have an adjustable ringer volume for use in different environments.
 - B. A backlit operators display shall be provided at each designated Master Telephone. This 4 x 20 LCD display shall continually show time, day and date. In addition, it shall show up to three (3) incoming calls (the fourth line indicates how many additional calls are in the queue).
 - C. The Master Telephone and display shall be housed in a #18 gauge surface mounted steel enclosure with a locking front door. The enclosure shall be 9"W x 14"H x 4"D.
- 2.18 The Area of Rescue station assembly shall be constructed of #22 gauge steel with tamper proof mounting hardware. The station faceplate shall be 7-3/4"W x 6-3/8"H and be flush mounted. The faceplate shall have the following features:
 - A. A large format momentary pushbutton for placing call for help shall be provided. Push-button shall be domed in shape and be bright red in color. It shall be a minimum of 1-1/2 inch in diameter and be activated with a minimum of effort for ease of use. No other hardware shall protrude from the station as high as the pushbutton.

- B. A 3" speaker shall be provided with a minimum frequency response of 250Hz-8kHz. It shall have a minimum voice coil diameter of 3/4", a 2.5-ounce magnet and be capable of handling 12 watts of program power.
- C. A high brightness LED shall be provided. It shall pulse at a fast flash rate when a call has been place, pulse at a slow rate when the station is connected to the Master Telephone and will stay on steady after the Master Telephone has hung up indicating "help is coming".
- D. A momentary rocker type pushbutton reset switch will also be provided. The reset switch will provide the means to reset the "help is coming" light at the station and also reset the display at the Master Telephone. Building personnel must respond to the area that placed the call to reset the station. A password protected command code shall be provided to enable a general reset from the Master Telephone.

2.19 CABLES

- A. All cable shall be as recommended by the manufacturer or an approved exact equivalent. All station wiring must be home run with individually jacketed cable.
- B. All Area of Rescue station wiring shall be in accordance with current new construction wiring guidelines published by the manufacturer, including speaker, call switch, and reset switch/LED.
- C. All interior Master Telephones shall be wired in accordance with current new construction wiring guidelines published by the manufacturer.
- D. All operator displays shall be connected to the system in accordance with current new construction wiring guidelines as published by the manufacturer.
- E. Transient suppression is required on all wiring leaving the building
- F. All cables run in underground conduits must be suited for wet locations.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Complete system shall be installed in strict accordance with manufacturer's recommendations.
- B. All wiring shall be installed in raceways where routed through plenum ceiling areas.
- C. Station wiring shall be Southwest Wire and Cable, Inc. #141298 or equivalent.
- D. Master Telephone enclosure shall be mounted 48" AFF to bottom of enclosure.
- E. Area of Rescue station shall be mounted so that the bottom of enclosure is 38" AFF.

3.2 INSPECTION AND TEST UPON COMPLETION

- A. Check-out and final connections to the 5115 system shall be made by a factory trained technician in the employ of a manufacturer of the products installed. In addition, factory trained technicians shall demonstrate operation of the complete system and each major component to the Owner.
- B. System field wiring diagrams shall be provided to this subcontractor by the system manufacturer prior to installation.
- C. All materials and installation shall be guaranteed to be free of defects in material and workmanship for one year after final acceptance of installation and test.
- D. Upon completion of the installation, four (4) copies of complete operational instructions shall be furnished, complete with record drawings. Instructions shall include part numbers and names, addresses, and telephone numbers of parts source. Final payment shall not be made until operational manuals have been received.
- E. Upon completion of the installation of the equipment, the electrical contractor shall provide to the engineer a signed statement form the equipment supplier that the system has been wired, tested, and functions properly according to the specifications.

- F. Nothing herein contained shall be construed to relieve the Contractor from furnishing a complete and acceptable electrical wiring system in all its categories. The engineer will condemn and reject any materials or labor which are or may become detrimental to the accomplishment of the intentions of these specifications.

END OF SECTION

SECTION 28 07 25
INTRUSION SYSTEM**PART 1 – GENERAL****1.1 SCOPE OF WORK**

- A. The Contractor shall provide, install, and program a functionally complete, integrated Intrusion System per Manufacturer's guidelines, codes described, within these specifications.

1.2 QUALIFICATIONS

- A. The alarm contractor shall provide all equipment and accessories for a complete electrically supervised security alarm system as described herein and shown in the drawings.
- B. Model numbers and designations, which appear herein, indicate design, quality, and type of material as well as operating characteristics.
- C. The security alarm system products shall be built modular in construction for ease of expansion and service. Functions shall be on replaceable panels or modules to accommodate functional changes when required. All critical wiring and connectors shall be supervised so as to give a trouble signal if removed or disconnected.

1.3 MANUFACTURERS

- A. The control/communicator, control stations, and programmers shall be supplied by SimplexGrinnell model Bosch 9512GV2 unless noted otherwise.

1.4 SUBMITTALS**A. Submittals at bid time:**

- 1. For bid evaluation, bid submittals shall include six (10) sets of the items described below:
 - a. Specification sheets (cut sheets) of all proposed equipment.
 - b. Equipment list identifying:
 - Model number of each unit.
 - Quantities of each type of device.
 - Unit costs
- 2. Specification compliance: A letter submitted with the bid, responding to specification subsections individually, indicating exceptions, substitutions, and alternates. The Contractor shall submit requests for substitutions (as well as all relevant technical data pertaining to the substituted equipment) to the specifier 10 days prior to the close of bid for evaluation and approval.

B. Submittals after award of contract:

- 1. Drawings: Shop drawings to provide details of proposed system and the work to be provided. These include point-to-point drawings of systems and wiring diagrams of individual devices.
- 2. Permits: The Contractor shall be responsible for identifying requirements for permits from the local police department for the installation of the alarm system specified herein and shall assist the owner in obtaining the relevant alarm permits.

1.5 DOCUMENTATION TO BE SUBMITTED BY THE CONTRACTOR UPON COMPLETION OF SYSTEM INSTALLATION

- A. "As-builts": Upon completion of installation, the Contractor shall prepare "as-built" drawings of the system. These "As-builts" shall be 30 in. x 42 in. (76 cm x 107 cm) reproducible drawings of each floor plan indicating exact device locations, panel terminations, cable routes and wire numbers as tagged and color-coded on the cable tag.

Additionally, final point-to-point wiring diagrams of each type of device (on 30 in. x 42 in. or 76 cm x 107 cm format) shall be included in the "as-builts."

"As-builts" shall be submitted to the Owner for approval prior to the system acceptance walk-through.

- B. Operation and maintenance manuals: Three (3) sets of operating manuals shall be provided explaining the operation and maintenance of the system.

1.6 ON-SITE SECURITY PERSONNEL TRAINING

- A. The Contractor upon completion of installation shall furnish training in the complete operation of the systems.

1.7 SYSTEM APPROVALS

- A. The system shall be the standard product of one manufacturer, and the manufacturer shall have been in business manufacturing similar products for at least 5 years.
- B. After-sales support: The Contractor shall be a factory-authorized and trained dealer of the system and shall be factory-trained and certified to maintain/repair the system after system acceptance.

1.8 QUALITY ASSURANCE

- A. All equipment, systems, and materials furnished and installed under this section shall be installed in accordance with the applicable standards of:

National codes: NEC, NFPA, UBC, BOCA, SBCCI

Approvals and listings: UL, FM, (CSFM, NYC-MEA, when applicable)

Local Authorities Having Jurisdiction

1.9 WARRANTY

- A. All components, parts, and assemblies supplied by the Manufacturers and installed by the Contractor shall be warranted against defects in material and workmanship for a period of at least 12 months (parts and labor), commencing upon date of acceptance by Owner. A qualified factory-trained service representative shall provide warranty service.

PART 2 – PRODUCTS

2.1 BASE SYSTEM PANEL (PC4020)

- A. The base panel shall have a capacity of 16 hardwired zones and the ability to accommodate up to 128 addressable devices on two addressable loops. The total capacity of the security control panel shall be 128 zones. All zones shall be fully supervised and programmable. Panel shall be complete with integral power supply and supervised battery charger, auxiliary power for powering security detection devices, programmable switched auxiliary power supply for 4-wire smoke detectors, integral supervised digital alarm communicator, supervised bell/siren output, and two general purpose programmable outputs which can be programmed as general purpose outputs or as the system's addressable loops.
 - 1. System Communication Bus: The system shall be complete with a standard, non-shielded, 4-conductor station wire bus for powering and communicating with remote hardwired system expansion modules and devices. For the connection of various system modules, communication bus wire runs (#18 AWG) of up to 3500 ft (1066 m.) shall be standard, and the system shall allow for an additional 3500 ft (1066 m.) of communication bus wire for each communication bus expander added (max. 16).
 - 2. Panel Zone Expansion: The panel shall be expandable to a maximum of 128 zones by adding standard hardwired 8 and/or 16-zone modules to the base panel, by adding up to 128 addressable detection devices to one or both of the addressable loops on the base panel, and by adding 64 wireless zones, and up to 8 wireless receivers to the four-wire communication

- bus. The system shall be capable of expansion using hardwired, addressable and wireless simultaneously in any combination that suits the application.
3. User Codes: The system shall provide for 1,500 user codes, select table as either 4 or 6 digits. For access control, user codes shall be assignable to 1 of 64 access levels. User codes shall be assignable to one or multiple partitions.
 4. Partitions: The system shall be programmable for up to 8 fully independent partitions, with each partition having its own account code. Keypads shall be assignable as partition keypads or global keypads. Each zone in the system shall be assignable to one or more partitions.
 5. Automation: The system shall be complete with an automation control module capable of controlling 32 X-10 or CEBus control devices, by event and by schedule. The system shall include 16 schedules to control automation devices. Automation shall be controllable from any system keypad and through a local or remote tone telephone.
 6. Scheduling: The system shall provide for 99 date schedules with 4 intervals per schedule, 4 holiday schedules with 2 years of scheduling capacity, 50 open/close suppression schedules and 16 automation schedules. All schedules shall be programmable from the LCD system keypads and by either local or remote upload/download.
 7. Ground Fault Detection: The system shall include an integral ground fault detector, which shall detect a single ground fault on any extended conductor in the system.
 8. Supervision: Each zone in the system shall be supervised. The base panel and any remote panel with its own AC input shall be supervised for AC loss. Batteries for the base panel and all remote panels shall be supervised for low power and be short circuit-protected. Each addressable device and each wireless input device shall be supervised for its presence. The communications bus shall be supervised for low voltage and the presence of each enrolled module and keypad. Digital alarm communicators shall be supervised for telephone line trouble and failure to communicate.
 9. Central Station Reporting: The system shall provide high speed 10 bps and 20 bps 1400/2300 Hz handshake, Contact ID and SIA reporting formats and shall be capable of being programmed to call up to 3 telephone numbers. The system shall also allow communication to a pager. The telephone numbers shall be programmable for backup dialing should the primary number fail. The system shall be programmable for split reporting so that alarms/restorals, openings/closing and miscellaneous events can be sent to different telephone numbers. The system shall report a separate account code for each partition and for non-partition (system) events. The system shall provide opening/closing scheduled suppression to prevent opens and closes from being reported to the central station. The system shall be capable of reporting all alarms, troubles, and system status information by combinations of all communication methods installed including: digital communication DVACS, and Cellemetry.
 10. TCP/IP LAN/WAN Communications: The system shall have the ability to communicate all alarm signals to a central station or dedicated PC (equipped with appropriate software), through a constant connection providing full supervision of the link between the panel and the TCP/IP receiver. Communication shall be via a LAN or WAN, compatible with 10BaseT and 100BaseT Ethernet TCP/IP communications.
 11. System Printer: The system shall be capable of output to a serial printer installed anywhere on the communication bus, and capable of printing all system events, alarms and restorals, including the partition, date, and time of these events.
 12. 2-Way Serial Port: The system shall support a 2-way data port, offering RS-232 serial communications at data transfer rates of from 300 to 4800 bps. This port shall provide real-time access to all system events and allow system integrators to send control commands to the control panel.

13. False Alarm Prevention: The system shall include the following false alarm prevention features:
- ☐ ☐ audible exit delay, audible exit fault
 - ☐ ☐ arm/disarm bell squawk
 - ☐ ☐ urgency on entry delay
 - ☐ ☐ TLM trouble and low battery trouble transmission delay
 - ☐ ☐ swinger shutdown programmable by zone
 - ☐ ☐ transmission delay by zone
 - ☐ ☐ police code (cross zone) transmission
 - ☐ ☐ opening after alarm transmission
 - ☐ ☐ recent close code transmission
 - ☐ ☐ AC fail
 - ☐ ☐ arming/disarming from outside the protected space using access control or wireless key
14. Power Supply/Relay Output Modules: The system shall be capable of including up to 64 fully programmable output relays with form 'C' contacts rated 2 Amps at 30VDC. Relays shall be added in modules of four and may be located anywhere on the communication bus. Each module shall include a supervised 700mA 12VDC battery charger, and integral power supply to supply up to 2.2 Amps of auxiliary power at 12VDC to power directly connected devices or repower the communication bus.
15. Low Power Outputs: The system shall be capable of including up to 144 low power outputs with each output able to supply 50mA at 12 VDC. Outputs shall be added in increments of 16 and may be added anywhere on the communication bus.
16. System Event Buffer: The system shall have a 3,000-event buffer. All events shall be printable from the system printer. The 2,800 most recent events shall be viewable on the LCD system keypad. All events shall be viewable by upload/download to a PC.
17. System Software: The base panel shall come complete with the software necessary to implement every system feature and to allow for the addition of every expansion or functional module without changes or addition to the basic software.
18. System Programming: The system shall be fully programmable from the LCD keypads and shall also allow event buffer viewing at the keypads. Separate PC-based upload/download software shall allow programming and operation from a directly connected local computer, or from a remote computer via a telephone line or TCP/IP LAN/WAN communications. Remote access shall be controlled by the owner to prevent unauthorized access. All system programming shall be maintained in nonvolatile memory so that programming information is retained even if all AC and battery power is removed.
19. Remote Annunciation: The system shall be capable of remote zone alarm and system status annunciation of up to 144 points, by adding 12, 32 and 64 point annunciators anywhere on the communication bus. Annunciators shall be capable of being flush-mounted. The annunciators shall provide point and/or graphic annunciation capability.
20. System Keypads (LCD4501): The system shall accommodate up to 16 LCD keypads which are powered from the base panel via the four-wire communications bus. LCD keypads shall have a display capacity of at least 32 alphanumeric characters with adjustable brightness and contrast. Keys shall be backlit for low light ease of use. Keypads shall include individual

"Armed", "Ready" and "Trouble" indicators, three keypad-activated alarm keys, and five programmable function keys.

2.2 MATERIALS

- A. Addressable Contact Input Module: Provide DSC model # AMP-701 input module for non-addressable devices. Uses 2-wire connection for power and data to the control panel. The AMP-701 has three alarm input terminals to which an external device can be connected. The terminals monitor alarm, tamper and trouble states.
- B. Interface to Door Hardware: Provide all necessary interface equipment required. Coordinate with door hardware provider.
- C. Passive Infrared Motion Detector: Provide as shown on plans PIR detectors.
 - 1. Wall-Mounted Units: Maximum detection range for individual units exceeds scheduled distance by 25 percent, but not less than 50 feet (15m)
 - 2. Ceiling-Mounted Units: Full 360-degree conical spot-detection pattern. With the device mounted at 8 feet above the floor the pattern at floor level is a minimum diameter of 24 feet. With device mounted at 12 feet above the floor the pattern at floor level is a minimum diameter of 40 feet.
- D. Door Switches: Provide as shown on plans magnetic type door switch.
 - 1. Flush-mounted units: unobtrusive, flush with surface of door frame and door.
 - 2. Overhead door units: door mounted magnet and floor mounted switch. Unit shall be listed for outdoor locations.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Install all equipment and materials in accordance with the "current" recommendations of the manufacturer. The work shall also be in accordance with:
 - 1. Installation criteria defined in these specifications and in the construction documents.
 - 2. Factory Representative.
 - 3. Approved submittals.
 - 4. Applicable requirements of referenced standards.

3.2 SUPERVISION

- A. The contractor shall provide the following services as part of the contract:
 - 1. Supervision of sub-contractors.
 - 2. Coordination of other contractors for system-related work (electrical contractor, finish hardware contractor, architect, and general contractor).
 - 3. Attending site construction/coordination meetings.
 - 4. Keeping updated construction drawings at the construction site.
 - 5. Meeting construction deadlines per the construction schedule.

3.3 PROGRAMMING

- A. Programming of the system shall include the following tasks:
 - 1. Programming system configuration parameters (hardware and software, zone/circuit numbers, communication parameters).

2. Programming operational parameters such as opening/closing reports and windows, system response text (custom English) displays of events, activation of relays that drive auxiliary devices, and identifying types of zones/loops.
3. Programming pass codes according to the authorities and functions defined by the owner.
4. Other system programming tasks required by the owner. These additional programming requirements shall be coordinated between the owner and the contractor.

3.4 TESTING

- A. Operational Testing: The contractor shall perform thorough operational testing and verify that all system components are fully operational.
- B. Hard-copy System Printout: The contractor shall submit a hard-copy system printout of all components tested and certify 100 percent operation indicating all devices/panels/units have passed the test criteria set forth by the manufacturer.
- C. Acceptance Test Plan Form: An acceptance test plan form shall be prepared/provided by the contractor prior to the acceptance walk-through.

This form shall include separate sections for each device/panel/unit as well as a column indicating the manufacturer's performance allowance/margin, a column indicating the result of the testing performed by the contractor (pass/fail), and an empty column for recording findings during the walk-through.

3.5 COMMISSIONING

- A. The contractor shall certify completion in writing and schedule the commissioning walk-through. The contractor shall provide all the tools and personnel needed to conduct an efficient commissioning process.

END OF SECTION

SECTION 28 07 27**INTEGRATED ACCESS CONTROL & SECURITY MANAGEMENT SYSTEM****PART I – GENERAL****1.1 GENERAL DESCRIPTION**

- A. The Security Management System (SMS) shall be a powerful, flexible, multi-function and object-oriented security and event management system that features a variety of customizable interfaces for maintaining the system and for monitoring the desired secure sites. The SMS shall provide an option to display these management and monitoring interfaces in the native languages of the people using the system. The security and event management system shall be flexible in order to meet specific requirements and quickly respond to evolving security challenges. The SMS shall be a scalable platform, simple and economical enough to support a single site, yet upgradeable enough to manage a multi-site network. The SMS shall use an open, distributed architecture, where database servers could reside in geographically separate locations.
- B. The SMS shall provide extensive information management capability using Microsoft .NET Framework V4.6. It shall operate in a Client / Server configuration on personal computers with a Windows-based platform. Its distributed client-server architecture shall be capable of supporting up to 256 simultaneous clients, multiple types of controllers, and over 20,000 input devices, including cameras and multiple types of card readers. The SMS shall be constructed to be database independent and shall support at a minimum Microsoft SQL Server 2008R2 (Express, Standard, or Enterprise), for data protection, redundancy and manageability.
- C. The SMS shall have true multi-tasking, multiprocessor and remote client support; allowing independent activities and monitoring to occur simultaneously at different locations. The operator workstation (Client) shall be user friendly, employing icon-based menus and providing a mouse-driven interface for system operation and the creation of color graphic maps. The user interface shall be customizable, capable of delivering a unique look and feel without a unique version release. It shall be an intuitive user interface that is similar to Microsoft's Outlook and Explorer with its easy navigation and tree structures. A practical application layout editor shall let users drag and drop any application onto one screen and create a customized hub for all activities via a single "command and control" center.
- D. Field devices such as card readers, alarm inputs, control points, etc. shall be connected to fully distributed intelligent field controllers or directly through a Software Development Kit or Web Services, and be capable of operating without host computer intervention. All objects within the SMS, i.e. doors, readers, time intervals, etc. shall be addressed by a unique name as opposed to point numbering or mnemonics. The SMS shall have badge generation tools to create and manage badges using a graphical interface and convenient query features to manage large numbers of badges.

1.2 SUBMITTALS

- A. Shop Drawings
 - 1. Prior to assembling or installing the SMS, the Contractor shall provide complete shop drawings which include the following:
 - a. Architectural floor plans indicating all system device locations.
 - b. Full schematic wiring information for all devices. Wiring information shall include cable type, cable length, conductor routings, quantities, and point-to-point termination schedules.
 - c. Complete access control system one-line block diagram.
 - d. Statement of the system sequence of operation.

- e. Riser diagrams showing interconnections.
 - f. Detail drawings showing installation and mounting.
 - g. Fabrication drawings for console arrangements and equipment layout.
 - 2. All drawings shall be fully dimensioned and prepared in DWG format using any CAD-based software capable of exporting the format (such as AutoCAD).
- B. Product Data
- 1. Prior to assembling or installing the SMS, the Contractor shall provide the following:
 - a. Complete product data and technical specification data sheets that include manufacturer's data for all material and equipment, including terminal devices, local processors, computer equipment, access cards, and any other equipment provided as part of the SMS.
 - b. A system description, including analysis and calculations used in sizing equipment required by the SMS. The description shall show how the equipment shall operate as a system to meet the performance requirements of the SMS. The following information shall be supplied as a minimum:
 - (1) Central processor configuration and memory size.
 - (2) Description of site equipment and its configuration.
 - (3) Protocol description.
 - (4) Rigid disk system size and configuration.
 - (5) Backup/archive system size and configuration.
 - (6) Start up operations.
 - (7) System expansion capability and method of implementation.
 - (8) System power requirements and UPS sizing.
 - (9) A description of the operating system and application software.
- C. As-Built Drawings
- 1. At the conclusion of the project, the Contractor shall provide "as built" drawings. The "as built" drawings shall be a continuation of the Contractor's shop drawings as modified, augmented, and reviewed during the installation, check out and acceptance phases of the project. All drawings shall be fully dimensioned and prepared in DWG format using any CAD-based software capable of exporting the format (such as AutoCAD).
- D. Manuals
- 1. At the conclusion of the project, the Contractor shall provide copies of the manuals as described herein. Each manual's contents shall be identified on the cover. The manual shall include names, addresses, and telephone numbers of each security system integrator installing equipment and systems and the nearest service representatives for each item of equipment for each system. The manuals shall have a table of contents and labeled sections. The manuals shall include all modifications made during installation, checkout, and acceptance. The manuals shall contain the following:
 - a. Hardware Manuals
 - (1) The hardware manuals shall describe all equipment furnished including:
 - (2) General description and specifications.
 - (3) System layout drawings and schematics.
 - (4) Manufacturers' repair parts list indicating sources of supply.

- b. Software Manuals: The software manuals shall describe the functions of all software and shall include all other information necessary to enable proper loading, testing, and operation. The manual shall include:
 - (1) Definition of terms and functions.
 - (2) Use of system and applications software.
 - (3) Initialization, start-up, and shut down.
 - (4) Alarm reports.
 - (5) Reports generation.
 - (6) Database format and data entry requirements.
- c. Operator Manual: The operator manual shall fully explain all procedures and instructions for the operation of the system including:
 - (1) Computers and peripherals.
 - (2) System start-up and shut down procedures.
 - (3) Use of system, command, and applications software.
 - (4) Recovery and restart procedures.
 - (5) Graphic alarm presentation.
 - (6) Use of report generator and generation of reports.
 - (7) Data entry.
 - (8) Operator commands.
 - (9) Alarm messages and reprinting formats.
 - (10) System access requirements.
- d. Maintenance Manual: The maintenance manual shall include descriptions of maintenance for all equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications

- 1. The manufacturers of all hardware and software components employed in the SMS shall be established vendors to the access control/security monitoring industry for no less than five (5) years and shall have successfully implemented at least 5 systems of similar size and complexity.

B. Contractor / Integrator Qualifications

- 1. The security system integrator shall have been regularly engaged in the installation and maintenance of integrated access control systems and have a proven track record with similar systems of the same size, scope, and complexity.
- 2. The security system integrator shall supply information attesting to the fact that their firm is an authorized product integrator certified with the SMS. A minimum of one technician shall be a Certified SMS installer.
- 3. The security system integrator shall supply information attesting to the fact that their installation and service technicians are competent factory trained and certified personnel capable of maintaining the system and providing reasonable service time.
- 4. The security system integrator shall provide a minimum of three (3) references whose systems are of similar complexity and have been installed and maintained by the security system integrator in the last five (5) years.

5. There shall be a local representative and factory authorized local service organization that shall carry a complete stock of parts and provide maintenance for these systems.

C. Testing Agencies

1. The SMS shall be tested and listed by Underwriters Laboratories (UL) for UL/cUL 294 for Access Control System Units.
2. The SMS shall be tested and listed by Underwriters Laboratories (UL) for UL/cUL 1076 for Proprietary Burglar Alarm Units.
3. The SMS shall employ a FIPS 197-listed AES 256-bit encryption between the SMS Servers, Clients, and iSTAR Ultra/eX/Edge Controllers.
4. The SMS shall include full support for FIPS 201 initiative:
 - a. Ability to customize a system-wide Card Holder Unique Identification number (CHUID).
 - b. Ability to configure custom, extended card formats, including GSA 75-bit Wiegand standard, and to download them to the card access panels.
 - c. Ability to use Hashed Message Authentication Codes (HMAC) for medium assurance profile.
 - d. Enhanced data fields per the FIPS 201 standard, including Agency Code, System Code, Credential Series and Credential Issue Code.
5. The SMS hardware shall comply with the following regulatory requirements:
 - a. FCC Class A.
 - b. FCC Class B.
 - c. CE.
 - d. Canadian Radio Emissions requirements.
 - e. Restriction of Hazardous Substances Directive (RoHS) 2002/95/EC.
 - f. FIPS 140-2 encryption (certified for the iSTAR Ultra/Edge/eX controllers).
6. The SMS shall support Americans with Disabilities Act (ADA) compliance in door and access operation.

D. Licensing: Licensing shall be required for the SMS software. The licensing shall include:

1. Series (Model).
2. Number of online readers.
3. Number of online inputs.
4. Number of online outputs.
5. Number of card holders.
6. Number of simultaneous clients.
7. Number of simultaneous badging stations.
8. Optional Features.

1.4 WARRANTY

- A. The SMS shall be provided with a 14-month product warranty from date of shipment or 1 year from date of registration, whichever is shorter. The SMS Hardware shall be provided with a 5-year product warranty from date of manufacture. Software version upgrades shall be available for no charge during this warranty. The software media warranty shall be 90 days per the C•CURE software licensing agreement.

PART 2 – PRODUCTS**2.1 MANUFACTURERS**

- A. The SMS shall be the Software House C•CURE 9000 system. The Badging Solution shall be Software House C•CURE ID. The SMS field controllers shall be the Software House iSTAR family of controllers. The hardware manufacturer shall be an ISO 9001:2000 registered company.

2.2 DESCRIPTION

- A. The SMS shall be an integrated system that utilizes a single, industry-standard relational database management system for the storage and manipulation of related data. The SMS shall include a server with operating system and applications software, operator and administrator terminals with appropriate software, hard copy printers and fixed magnetic storage media. The security devices shall communicate with the field panels via a dedicated cable network. The field panels shall communicate to the server via a Fast Ethernet 10/100 or 1 Gb, TCP/IP network.
- B. The SMS shall allow for growth and scalability from a low-end or entry level system to a high end or enterprise system by increasing CPU power, memory and database. The SMS shall be modular in nature, allowing system capacities to be easily expanded without requiring major changes to system operation. All defined system data as well as historical information shall be maintained. Customizable user interfaces shall allow management of system information and activity for administrators and operators. The SMS shall include an intuitive .NET based badging solution with a WYSIWYG badge layout editor and GUI for badge design.

2.3 SMS Functionality**A. Partitioning**

- 1. The SMS shall allow system administrators to separate the creation and viewing of objects into partitions. SMS operators shall be associated with partitions and this shall determine which objects operators have the ability to create and or view. The SMS shall support an unlimited number of partitions.
 - a. The SMS partitions shall include but not be limited to the following objects:
 - (1) Personnel
 - (2) Clearances
 - (3) Doors
 - (4) Controllers with all associated hardware (readers, inputs, outputs, etc)
 - (5) Video servers with all associated objects (cameras, tours, views, etc)
 - (6) Application layouts
 - (7) Events
 - (8) Dynamic views
 - (9) Maps
 - (10) Reports, forms, results
 - (11) Holidays
 - (12) Badge layouts
 - (13) Queries
 - (14) Images
- 2. Through the use of privileges, the SMS System Administrator shall be able to determine which objects are associated with a particular partition. These objects shall then be assigned

- to System Operators with the appropriate privilege.
3. The SMS shall support a super-user assigned the 'System All' privilege who shall have full access to all objects in all partitions.
 4. Any operator shall have the ability to be assigned access rights to any partition. Individual Access rights shall be created and have the ability to be assigned to any users of the SMS.
 5. The SMS shall allow objects to be created in any partition. The SMS shall have the ability to grant or remove permission from any object in any partition.
 6. The SMS shall provide the ability to move objects from one partition to another partition without the requirement of deleting and recreating.
 7. The SMS shall provide the ability to import/export any configured object.
 8. The SMS shall support the display of all associated objects contained within a partition.
- B. Enterprise Architecture
1. The SMS shall provide an Enterprise Architecture, licensable option that allows you to configure multiple Satellite Application Servers (SAS) to communicate with a Master Application Server (MAS). The Master Application Server shall provide a platform for global management of the personnel, video, and access control security objects on two or more Satellite Application Servers (SAS) in an enterprise.
 2. The Enterprise Architecture shall work by synchronizing each SAS system's database with the MAS database. The MAS shall contain the global data that is used across every server, such as global personnel records, global clearances, and global schedules. The global data shall be synchronized to each SAS to provide enterprise-wide security. The MAS shall be used to remotely monitor and manage controllers and video servers attached to SAS's in the enterprise, however it shall not support any directly connected controllers or video servers.
 3. The MAS shall provide the capability for Central Monitoring of the entire enterprise, using the Monitoring Station application. From a Central Monitoring Station connected to the MAS, the system shall be capable of viewing events, activities, and status of every SAS in the enterprise. Alternatively, you can connect to an individual SAS to monitor that system and its connected hardware. In addition, the MAS shall provide the ability to integrate with external sources via LDAP, XML, CSV or ODBC imports both manually or automatically through scheduled processes.
 4. Each SAS shall contain database records for all connected video and access control devices, as well as local personnel, clearances, privileges, and other related data. Each SAS shall synchronize with the MAS so that SAS local data is replicated to the MAS for central management and monitoring. In addition, the MAS shall provide central reporting capability for replicated SAS objects including journal and audit transactional data. [Note, for Connected Program integrations, SAS local data is not replicated to the MAS and central reporting is limited.]
 5. All local data shall be synchronized immediately to the MAS or queued if a server is offline. All queued data shall be replicated automatically upon restoral of communication. Global data that is created or changed at the SAS/MAS shall be replicated to all locations. Journal and Audit data shall be synchronized either manually or on a configurable schedule, providing the ability to manage bandwidth usage and load balancing.
 6. Operators in the enterprise architecture shall be configured as local or global. Global operators shall be subject to the user privileges as defined on each SAS.
 7. The Enterprise Architecture shall support a Standalone to SAS Migration Utility that shall be used to merge a standalone SMS server into an existing SMS Enterprise site.

8. The Enterprise Architecture option shall include:
 - a. Global Administration of Personnel and Clearances, Images, Card formats, CHUID Formats, Holidays, Personnel groups, and Operators and Privileges
 - b. Centralized Reporting
 - c. Central Monitoring of Events and Activities across the Enterprise
 - d. Central Management of Access Card Enrollment
 - e. Central Badging and Image processing
 - f. Global Management of Badge Layouts
 - g. Single Card Access across the Entire Enterprise
 - h. Increased Scalability of Security Hardware and Video
 - i. End-to-End Encryption
 - j. Automated Synchronization of Enterprise Security Databases
 - k. Central Management of Video and Hardware Resources
 - l. Remote Editing of Global and Local Data
 9. The SMS Enterprise model shall not restrict the addition and/or configuration of over 40 regional application servers configured to a master application server. Testing and qualification has been completed for up to 40 regional servers. However, the SMS shall have no technical restrictions to regional server capacity limits other than system performance.
 10. The SMS shall support the configuration of multiple Global partitions in addition to the default Global partition providing the SMS more organization options for objects within the Enterprise system.
 11. The Enterprise Architecture option shall provide Multi-Version support. Multi-Version support shall allow SASs running a prior version of the SMS software to continue to synchronize with the MAS allowing for a phased deployment during an Enterprise-wide upgrade. Client connectivity between MAS and Multi-version SASs for monitoring and administration is supported
- C. Graphical User Interface (GUI)
1. The SMS shall employ a standard Windows graphical user interface (GUI). A mouse and keyboard shall be the primary operator interface with the system. Operator screens shall utilize all standard Windows-style functions such as drop-down menus, context menus, radio buttons, and lists, as appropriate. The interface shall utilize a 'tree structure' similar to Windows Explorer.
- D. Administration Operator Interface
1. The SMS shall employ an Administration Operator Interface to control the following:
 - a. Hardware (readers, inputs, outputs, video systems, door controls, CCTV, and other systems).
 - b. Configuration of personnel records, operators and operator privileges.
 - c. Graphical Maps.
 - d. Application Layouts.
 - e. Dynamic Views.
 - f. Queries.
 - g. Import/Export of objects, including images.

- h. System Variables.
 - i. Reports (either periodic or one-time).
 - j. System functions (event command and control, actions, schedules).
 - k. Display of a list of objects in a grid that can have their values modified and respond to real-time status changes.
 - l. Scheduling of backups.
 - m. Monitoring of system settings and performance.
 - n. Designing of and printing of badges.
 - 2. The GUI shall be configurable by the system administrator to control the views and access of each Monitoring Station operator.
- E. Monitoring Operator Interface / Activity Monitoring
- 1. The SMS shall contain a monitoring component that is capable of, among other things, displaying the current state of any object in the system. Additionally, the monitoring station shall be capable of displaying a log of all activity that occurs in the system, from object state changes, to access control information. All text for events (alarms) in the system shall be configurable to be displayed in color based on the user-specified priority of the event.
 - 2. The Monitoring Station shall be capable of showing all changes occurring to an object without requiring the associated activity messages for that object to be routed to that monitoring station. The SMS shall require the operator to have appropriate permissions to view and/or control any object.
 - 3. The monitoring station interface shall be user-customizable. The SMS shall support the ability of the end user to create a customized application layout for the monitoring station. The monitoring station shall support multiple application layouts that can be assigned to the operators. Each application layout can have multiple panes in the same window. The panes can have multiple tabs so that different objects such as cameras and tours can be displayed in the same pane. The panes shall have the ability to include: General activity; Event (Alarm) activity; Dynamic card swipe information; Video cameras and tours; Maps; Dynamic Views; Reports; and links to external applications. Each pane shall have the ability to be moved to a specific screen.
 - 4. The SMS monitoring station shall support a Swipe and Show Viewer. The Swipe and Show Viewer shall monitor a configurable list of Doors, and shall display a portrait or multiple portraits of personnel who present an access credential at a Reader on an included Door or Elevator. The SMS shall allow multiple Swipe and Show Viewers to be added to an Application Layout. The Swipe and Show Viewer shall provide configurable image border colors that shall correspond to access transaction states (Admit, Reject etc.). The Swipe and Show Viewer shall display the date and time of the transaction, the location, area, Cardholders name and the status of the transaction. The Swipe and Show Viewer shall allow an Operator with the appropriate Privileges to perform the following functions from the Viewer:
 - a. View/Edit the Cardholder record
 - b. Perform a momentary unlock of the associated door
 - c. Grace the Cardholder (allow the cardholder into an APB area)
 - d. Perform an Area Lockout Grace of the cardholder
 - e. Perform an APB reset on the cardholder

5. The SMS shall support the ability to configure an Operator's Application Layouts to open in separate instances of the Monitoring Station to enhance the performance of multiple displays. Each Application Layout shall support the assignment of a monitor number. The Operator opening the Monitoring Application shall automatically open a separate instance of the Monitoring Application on each assigned Monitor. The SMS shall support up to Ten (10) assigned monitors for Application Layouts.
6. The SMS shall provide the Monitoring Operator with following functional capabilities:
 - a. Shall provide a scrolling list of lines or tiles showing current activity on the system.
 - b. Shall display activity in real-time as data is being transmitted by field hardware.
 - c. Shall include icons that indicate the type of activity and textual description of the activity.
 - d. The color of the frames of the tiles, icons, and/or text shall indicate the type or importance of the information contained therein.
 - e. A series of menus, driven by drop-down or trees, shall allow the Monitoring Station operator to perform manual actions, such as “momentary door unlock” for a given door.
 - f. As part of the manual action capability, the system shall provide screens or boxes that query the operator on specifics, such as start and end time, and offer guidance on performing the manual actions.
 - g. Ability to view a sortable list of active alarms or events and recently active alarms or activity.
 - h. Ability to view video from DVMS systems within the same GUI. The video screen GUI shall be able to display multiple panes of live or recorded video and have on-screen camera controls for each live window, providing PTZ control of individual cameras.
 - i. A GUI that minimizes the number of operator mouse clicks or keyboard strokes.
 - j. Mouse controls include “right-click” pop-ups and highlighted default selections.
 - k. Objects shall be displayed to the operator based on his/her assigned operator privilege. The operator shall only be able to monitor/command those objects for which he or she has been assigned privilege.
 - l. When an operator logs out of a workstation and a new operator logs on, the objects displayed on the workstation screen shall be dynamically updated to display only those objects for which the new operator has privilege.
 - m. Allow the customization of columns as defined by the operator privilege, including:
 - (1) Adjusting width (on the fly or pre-programmed).
 - (2) Not displaying Columns (on the fly or pre-programmed).
 - (3) Sorting on selected columns (to follow standard Windows conventions).
 - n. Allow for a “freeze” function. This includes a configurable “freeze time-out” that permits an activity to be selected and temporarily prevents the display of subsequent activities which push the selected activity off the screen. A break-through event disables the freeze function. The freeze function shall provide a graphic bar where the remaining time available in the freeze timeout shall be displayed. Selecting the freeze timeout icon before the time elapses shall extend the freeze timeout to the maximum.
 - o. Provide Acknowledge All, Acknowledge and Clear All and Silence All buttons for events.
 - p. Support multiple panes for the display of events, activities, video, personnel images, and maps.

- q. Display the number of active causes of an event.
 - r. Support the ability to attach a log message to an event, even after the event has been acknowledged.
 - s. Provide the ability to attach Predefined Log Messages to an event upon acknowledgement.
 - t. Shall allow a Monitoring Operator to select on-screen transactions (both events and system activity) and Email the transactions with a single mouse click.
7. Pre-defined Alarm Acknowledgement Messages
- a. The SMS shall provide the ability to create Predefined Log Messages. Each log message shall have a Name, Description, Label and Message Text. These messages shall be assigned to any event providing the ability to select the appropriate response that resolved the event. The SMS shall provide the ability to group multiple log messages and then assign the group to an event. Each group shall contain up to one hundred messages and each event shall support up to one hundred messages. The SMS shall allow only users with specified operator privileges to add, modify, or delete messages or message groups. Predefined messages shall be editable by an operator with the proper privilege and may be appended as required by the operator.
 - b. Messages shall have the following characteristics:
 - (1) Message Name shall be configured with up to 500 characters
 - (2) Message Description shall be configured with up to 500 characters
 - (3) Message Label shall be configured with up to 100 characters
 - (4) Message Text shall be configured with up to 3000 characters
8. The SMS shall support audible alarm annunciation at operator workstations (operator configurable audio [WAV] files associated with alarms).
9. The activity monitoring screen shall be capable of displaying the following features:
- a. System clock.
 - b. Date/time when the activity actually occurred and the date/time when the activity was received by the server shall be displayed (when they are different).
 - c. Real time event counters.
 - d. Count of the active events.
 - e. Count of the events requiring operator acknowledgment.
 - f. Name of operator logged on at the workstation.
 - g. Real-time display of the current activity on the system in chronological order.
 - h. Acknowledge All and Silence All buttons for events.
 - i. Manual Action command buttons.
 - j. Pre-defined and configurable acknowledgement messages.
 - k. Log message.
 - l. Clear event.
 - m. Clear group of events.
 - n. Event action message (automatically display selected message for event).
 - o. Dynamic views.

F. Web Client

1. The SMS shall support a Thin Client to provide remote access to the SMS Server via a web browser. The Thin Client shall support Microsoft® Internet Explorer 7.0 and Mozilla Firefox® 3.0 or greater. The Thin Client shall support 128-bit AES encryption to the SMS Server.
2. The Thin Client shall support Single Sign-on utilizing Windows Authentication. The privileges of the SMS operator shall be propagated to the Thin Client User allowing only access to Security Objects for which the SMS Operator is authorized. The Thin Client shall provide support for Partitioning of the system and utilize the Partitions assigned to the Operator.
3. All changes made to the SMS database via the Thin Client shall be recorded in the Audit Trail Database.
4. The Thin Client shall provide Personnel Management including:
 - a. Shall allow the operator to create and modify personnel data (includes adding/removing clearances, schedules, and expiration dates).
 - b. Operator shall have the ability to enable and disable cards.
 - c. Operator shall have the ability to search for, edit, add, and delete Personnel records from the SMS database.
 - d. Search function shall allow wildcards and shall include First name, Last name, card number, and user defined text.
 - e. Shall support the Auto-increment Card Number feature for Credentials created using the Web Client.
 - f. Shall support a Change CHUID Format button on the Credentials tab that allows you to change the CHUID format of a Credential.
 - g. Shall support an Auto Generate button that allows you to randomly generate a PIN for PIN-only Credentials.
 - h. The SMS thin client shall provide a personnel image tab that includes image display, Image capture from a file or a local USB camera, and the capability to crop the Image and save it to the SMS personnel record.
 - i. The SMS thin client shall support the previewing/printing of badges.
5. The Thin Client shall support an Activity Monitor to provide a scrolling display of system activity. Activity shall be restricted based upon the Operator's Privilege and Partition assignments. Display controls shall include page up, page down, and a freeze function.
6. The Thin Client shall support acknowledgement of an Event from the Event Dynamic View.
7. The Thin Client shall support for logging an Event Message from the Event Dynamic View
8. The Thin Client shall support Manual Actions to include the Locking/unlocking of doors, and the Activation/deactivation of events.
9. The Thin Client shall support the display of Dynamic Views as defined by the SMS. Dynamic Views shall provide a real time view of SMS data including Journal and Audit Trail history. Viewing of Multiple Dynamic Views shall be supported.
10. The Thin Client shall support creating, configuring, loading and saving of reports. Reports shall consist of personnel history activity or audit data. The report data shall allow sorting within the thin Client view page by any displayed field in ascending or descending order. The Thin Client shall allow reports to be saved in the following formats: XLS, CSV, XML, TXT or PDF. The operator shall have the option to save the report to a file or send it via email.

11. The Thin Client shall support Manual Action Challenges. The Manual Action Challenge shall require an operator to enter their login credentials (User name and password) when executing a manual action, such as a door unlock, from within the Thin client.
12. The Thin Client shall support the ability to query on a specific cardholder or a group of cardholders for the purpose of assigning clearances to multiple cardholders at once. Once the query is complete, the operator shall have the ability to assign a single access clearance or a group of clearances to all cardholders.
13. The Thin Client shall support the ability to display a door activity report from the web client cardholder record configuration view. In addition, it shall provide the ability to display the Activation / Expiration Date and Time for each credential assigned to a cardholder. The thin client shall display all user-defined personnel fields and the details of each assigned access clearance in a separate window.
14. The Thin Client shall support Auto-Logoff based upon inactivity. The Thin Client shall monitor user activity and shall automatically log a user out of the workstation after a user defined timeout period.
15. The Thin Client shall support the ability to assign or remove clearances to multiple cardholders simultaneously.

G. SMS Mobile Application

1. The SMS shall support a Mobile Application allowing operators to monitor or administer the SMS system by way of mobile device. The device shall be connected via the phone network and a VPN or via Wi-Fi to the SMS server utilizing Web Service (IIS - Web Service).
2. The SMS Mobile software shall be available for download from the following locations:
 - a. Apple App Store
 - b. Google Play
3. The Mobile Application shall support mobile phones and tablets running the following operating systems.
 - a. Apple iOS 7.1 and higher (iPhone, iPad, iPod Touch)
 - b. Android OS 4.0 and higher
4. The Mobile Application shall connect to a standalone SMS server, including an Enterprise Satellite Application Server (SAS) and Site Server (Appliance).
5. The SMS Mobile Application shall support connection to the SMS system through a 3G (minimum), 4G, or Wi-Fi connection.
6. The number of mobile connections allowed by the SMS server shall be based on the SMS licensing model. Each connection made through the SMS Web service shall be considered a simultaneous client connection.
7. Operator login to the SMS Mobile Application shall be consistent with the SMS thick client application, authenticating login credentials via Windows Single Sign-On (SSO).
8. The SMS Web Service shall require Internet Information Services (IIS) be installed on the target system. The SMS Web Service shall be installed on the IIS server during installation.
9. The SMS Mobile Application user interface shall be localized with supported SMS languages: Arabic, Czech, Danish, Dutch, English, French, German, Hungarian, Italian, Japanese, Korean, Polish, Portuguese (Brazilian), Russian, Simplified Chinese, Spanish, Swedish, Traditional Chinese, and Turkish.
10. The SMS Mobile Application shall support SSL-encrypted communications with the remote Mobile Web Service.

11. The SMS Mobile Application shall provide a search and filter option to refine query results.
12. The SMS Mobile Application shall provide a link to a context menu while viewing objects, providing the operator the ability to perform SMS operations consistent with the SMS administration and monitoring applications.
13. The SMS Mobile Application shall provide the following core features:
 - a. The SMS Mobile Application shall provide operators with the appropriate privilege, access to tools used for inspecting the SMS Journal and Audit Logs.
 - b. The SMS Mobile Application shall provide a collection of tools to monitor SMS events and other objects. Monitoring shall show active SMS events in real time.
 - c. The SMS Mobile Application shall provide a collection of tools to manage personnel and shall allow for the following:
 - (1) Create/Update Personnel Records
 - (2) Assign/Remove a card/credential to personnel.
 - (3) Capture an image and associate that image with personnel.
 - (4) Grace personnel, Antipassback Card Reset, Area Lockout Grace, and remove personnel from an Area
14. The SMS Mobile Application shall provide tools used to explore, edit and control the following objects:
 - Favorite Filters
 - Favorite Monitors
 - Query
 - Events
 - Manual Actions
 - Operators
 - Controllers
 - Doors
 - Elevators
 - Inputs
 - iSTAR Clusters
 - Outputs
 - Readers
15. The SMS Mobile Application shall provide an editor for local application preferences such as:
 - a. Login Parameters – Encryption, Inactivity Timer, etc.
 - b. Data Collection – Page Size
 - c. Monitoring – Polling Intervals, etc.

H. Graphic Maps

1. The SMS shall support unlimited graphic maps and icons to be displayed on the operator workstation monitor.
2. The system shall support an operator-programmable, color graphic map display that:

- a. Shall be capable of showing the floor plan, the location of alarm devices, and alarm instructions for a facility.
 - b. Shall be centralized in the system configuration and displayed on the operators' workstations.
 - c. Shall allow various maps to be associated with different areas to create a hierarchy of maps.
 - d. Shall support graphic maps having a resolution of 1024x768 Pixels or greater.
 3. Operators shall be able to use drag-and-drop mouse technique to place dynamic system level object icons of all objects such as: cameras, video servers, inputs/outputs, events, maps, reports, dynamic views, and door/elevator icons. These dynamic object icons shall allow a system operator to perform tasks and issue commands related to the object by double-clicking on the icon.
 4. The SMS shall allow the addition of new layers to the drawing (such that if the drawing must ever be reloaded due to an update of the drawing, the layer(s) created within the SMS will be added back automatically without additional reconfiguration).
 5. The SMS shall be able to directly import the following file formats for the map:
AutoCAD (.DWG)
DXF
JPEG (.JPG)
PNG
 6. The Maps feature shall include two operational modes: an administrative mode to allow configuring of the facility floor plans or site plans that show exterior features and a runtime mode to allow monitoring and interacting with the configured facility layouts or site plans.
- I. Information Storage, Backup and Transfer
1. All programmed information, as well as transactional history, shall be automatically stored in the database for later retrieval and backup. The SMS shall support configurations where the SMS database(s) may be installed on a hard drive on the SMS server, on an independent database server, or in an existing corporate database server.
 2. The SMS shall be capable of backing up and restoring all system data and transactional history. The server shall be capable of transferring all programmed data and transactional history to CD-ROM, DVD, or Hard Drive (including networked drives).
 3. The SMS shall allow activity history to be written to a database. The system shall have the capacity to store a minimum of 50 million transactions. There shall be a method of backing up the activity history on external media and then restoring and replaying it.
 4. The SMS shall support AES 256-bit encrypted communications between server and user client.
 5. The SMS shall support AES 256-bit encrypted communications between server and controller. The encryption shall support both local and third-party digital certificates.
- J. Communication Ports
1. The SMS shall be able to support multiple serial devices. In addition to COM1 and COM2, up to [8, 16, 32, to 256] additional ports may be configured through the use of a port expander or its equivalent. These serial ports may be used for connection to CCTV matrix switchers, or apC panels.
 2. The SMS shall support the use of Ethernet networks as the communications path between the

host computer and field devices such as, iSTAR, apC, apC 8/x, controllers, and CCTV matrix switchers. This communications path shall be the same network used for communications between the host server and the operator workstations. The communications between the host computer and the field devices shall be encapsulated in a TCP/IP network/transport layer. The SMS shall support IPv6. (IPv6 shall be supported only on iStar Ultra controllers.)

K. Printers

1. The SMS shall support report printing. The report printer(s) may be connected directly to the client PC, or shared over a network. The SMS shall support as report printer(s) any printer for which a printer driver exists within the Operating System supported by the current SMS version.

L. Software Configuration

1. The SMS configuration tools shall utilize intelligent configuration controls. The system shall be structured so an operator is unable to perform configuration functions that are invalid based on the configuration used. The system shall support the ability to search within browser lists using filtering operators such as “begins with”, “ends with”, “contains”, etc. The system shall also allow an operator to do searches using filtering operators on any class of object in the system, both in the Administration application and the Monitoring Station application.
2. The SMS shall allow text description of all configured objects. The SMS shall allow the renaming of an existing title description without removing the sub-components of that configuration object. The SMS shall automatically remove from the system all configuration references to an object being deleted. The SMS shall automatically provide default names for all inputs, outputs, readers, and extension boards. The SMS shall clearly display which hardware objects (inputs, outputs, readers) on a controller are configured, and which are not.
3. The SMS shall provide for the configuration of templates. Templates of supported objects shall be operator-configurable to provide default values by pre-populating commonly used data fields.
4. The SMS shall support an unlimited number of groups for any object type. The SMS shall support unlimited object group definitions. In general, a group shall be usable wherever an individual object is referenced in the SMS. For example, a group may be used instead of an object when configuring a schedule/object pair in a clearance, and a group may be used instead of an object when performing a manual action to unlock a door.
5. The SMS shall generally allow any object in the system to be grouped including personnel, doors, inputs, outputs and clearances.
6. The SMS shall restrict the viewing and controlling of objects in the administration and monitoring stations via operator privileges. The SMS shall support the configuration of operator restrictions on an object class basis, and on an object-by-object basis. The SMS shall maintain a distinction between objects that are being monitored and objects that are being controlled, preventing operators from issuing object manual actions to objects for which the operator does not have manual action privileges. There shall be different levels of controls within the system for administration privileges versus monitoring privileges.
7. The SMS shall support unlimited operator accounts with unlimited definable privilege levels.
8. The SMS shall allow configuration of controllers using hierarchical tree-based navigation and context menus.
9. The SMS shall support the ability to download firmware updates to the controllers.
10. The SMS shall support the following methods for Operator authentication and authorization:
 - a. Windows Single Sign-On (SSO).

- b. Basic User Authentication with locally defined user names and passwords with strong password rule enforcement.
- 11. The SMS shall provide an automatic client update process for quick distribution of application updates.
- 12. The SMS shall have context sensitive online help (at the screen level) available at any point requiring operator input.
- M. Personnel Records
 - 1. The SMS shall provide Personnel Templates that shall eliminate repetitive data entry by pre-configuring Personnel Records with data common to all Personnel.
 - 2. The SMS Personnel records shall provide multiple tabbed pages of personnel data containing default system and user-defined fields. The SMS shall support an unlimited number of tabs allowing an unlimited number of user-defined fields. Labels for user-defined field tabs shall be customizable by the System Administrator with the appropriate privileges. Each user-defined field shall allow a name, description and label. A default language shall be selectable by the System Administrator for the user-defined field labels.
 - 3. User-defined fields shall be definable as Mandatory or Unique and shall support the following field types:
 - Character
 - Integer
 - Logical
 - Date/Time
 - Date
 - Time
 - Enumerated List
 - Multi Line
 - Decimal
 - Identity
 - 4. User-defined fields shall support masking to provide consistency of data entry across all system operators. Custom masks, as well as the following predefined masks, shall be available:
 - Alphabetic
 - Alphanumeric
 - Numeric
 - Phone Number – USA
 - Zip Code
 - Zip Code +4
 - Alpha – All Caps
 - Alpha – All Lower case
 - 5. The SMS shall provide a “Personnel Record Document Object” option which allows the operator to assign / attach up to two (2) documents (such as URL, PDF, or TXT files) to the personnel record. The document may be applied to the record as a:
 - a. 'Shared' Document - added to the SMS via the Documents Editor.

- b. 'Private' Document - imported from outside the system, such as a birth certificate or a diploma.
 6. The SMS shall include a "Documents" tab to user-defined personnel views as well as the default view "Personnel View with Portrait in Header" to support the association of documents. The documents are available for viewing by operators with appropriate privilege.
 7. The SMS shall support the generation of a unique random card number for an access credential for all Personnel records. The unique card number shall contain up to the maximum number of digits for the CHUID format chosen for the credential.
 8. The SMS shall support the configuration of a trigger for a Personnel record that pulses an Event whenever a 'Card Admitted'/'Card Rejected' message is logged to the Journal for that person at a defined Door/Elevator.
 9. The SMS shall support an email address field for each Personnel Record and shall support the sending of emails to Personnel Groups.
- N. Credentials
1. The SMS shall support a minimum of five (5) credentials (cards) per Personnel record and shall only count Active and/or Expired Cards towards the maximum assignable Cards per Person. Cards designated as Lost, Stolen and Disabled shall not count towards the maximum assignable Cards per Person.
 2. The SMS shall support the ability to define the default period of time (in Days, Hours or Years) from a Credential's Activation Date until its Expiration. The SMS shall support an override of the default Expiration time period for individual Personnel Types.
 3. The SMS shall support Temporary Credentials. Temporary Credentials shall be available for general re-use without being associated to specific Personnel records. Temporary Credentials shall be assignable to visitors and can also serve as temporary replacement cards for Personnel who misplaced or forgot their regular Credentials. The SMS shall support the configuration of a default number of days for Temporary Credentials to remain active after they are created.
 4. The SMS shall provide the ability to define background colors for the Active/Expired Credential Status fields in the Personnel Record.
 5. The SMS shall support a system-wide setting to automatically disable Personnel Credentials that have not been used for a specified period of time. The Disable by Inactivity process shall support a user configurable daily scan time.
- O. Personnel Views
1. The SMS shall support user-defined Personnel Views. Personnel Views shall provide the ability to customize the Personnel record by adding and/or removing certain objects from the operator's view. Personnel Views shall be assignable to SMS operators via the operator's assigned privilege and shall be definable for use in the creation and/or editing of the Personnel record. All Personnel Views enabled for an operator shall be selectable from the current view to allow an operator to switch views in real time. Personnel Views shall support the following:
 - a. Adding/Removing Fields (including all user-defined fields)
 - b. Custom Field Labels
 - c. Adding Boxes to group together common fields
 - d. Adding/Removing tabs to organize fields
 - e. Custom Tab Labels

- f. Customization of Tab display order
 - g. Background/Foreground color control of fields and labels
 - h. Personnel Record Document Object – to associate up to two (2) documents to the record
- P. Language Localization
 - 1. The SMS shall be configured so the information presented to system operators is displayed in a language native to the system operator provided that the proper translation files exist.
 - 2. It shall be possible to translate the SMS into any left-to-right or right-to-left language supported by Unicode and by the Microsoft Windows operating system.
 - 3. Languages shall include English, Arabic, Brazilian Portuguese, Dutch, French, German, Italian, Polish, Simplified Chinese, Spanish and Japanese.
- Q. Inputs
 - 1. The SMS shall monitor both supervised and unsupervised hardware inputs as well as virtual inputs such as predefined system messages. These inputs include door / elevator inputs and monitor points. The SMS shall also monitor controller inputs such as tamper, AC fail, and low battery.
 - 2. The SMS shall have the ability to name and allow for user-defined descriptions for individual inputs, outputs, and readers as well as input and output modules.
 - 3. There shall be three separate and distinct states for inputs, which can be defined on the input configuration screen: Disabled, Enabled / Disarmed and Enabled / Armed.
 - 4. The SMS shall allow configuration to link the state of an input to an output. The system shall allow multiple inputs to activate a single output or group of outputs.
- R. Outputs
 - 1. The SMS shall have outputs, also known as Control points, which associate an input or event action with a relay output. These output uses include doors / elevators, alarms and industrial control.
 - 2. There shall be three types of outputs available: dry contact / Form C relays, wet or voltage sourced relays and Open Collectors. Outputs shall be configured such that they can be activated, deactivated or pulsed by system actions.
- S. Card and Reader Support
 - 1. The SMS shall be designed to support multiple card formats and card reader types.
 - 2. The SMS shall support the following features for directly connected readers:
 - a. OSDP. (Open Supervised Device Protocol), v2.1.6 or higher. OSDP shall only be supported with the iStar Ultra and qualified OSDP capable readers, using OSDP Secure Channel AES128 encryption.
 - b. User defined card formats up to 256 bits.
 - c. Unlimited number of SMS card formats.
 - d. The ability to assign up to 10 card formats per reader.
 - e. The ability to show reader status on RM LCD.
 - f. Support Wiegand and 3x4 matrix keypads.
 - g. The enrollment of biometric templates to smartcards.
 - h. Custom CHUID FIPS201-compliant supporting full 256-bit data.
 - i. The SMS shall support readers that provide Wiegand signaling and magnetic signaling to include:

Software House RM readers.
Software House Multi-technology readers.
Wiegand swipe/insert readers.
Proximity readers.
Biometric readers.
Smart card readers.
Wireless readers.
Magnetic readers.

T. Advanced Door Monitoring

1. The SMS shall support Advanced Door Monitoring allowing additional monitoring inputs and lock sensing equipment at all doors. Advanced Door Monitoring shall allow integration with third-party lock release inputs, such as fire and crash bar devices, that control emergency egress.
2. Advanced Door Monitoring shall include:
 - a. Multiple inputs – Advanced Doors shall support up to 16 inputs.
 - b. Single and double-leaf doors with multiple DSM or Request To Exit (RTE) inputs.
 - c. Shall support Lock sensing devices – to monitor locking on magnetic bonds, bolts, and cams.
 - d. Integrated lock releases – to integrate door unlocking with fire, crash bar, power fail, and key switch inputs.
 - e. Special events and actions – to create keypad commands that lock, unlock, and secure doors for a specific time period.
 - f. Alarm Suppression and RTE control on a per door basis.
 - g. Enhanced Shunt control.
 - h. Grace and change timing options – to fine tune the SMS timing to avoid the effects of ‘door bounce’.
 - i. Journal reports and Monitor Station activities – to manage the system and monitor door activity.
 - j. Additional Event Actions related to Advanced Doors

U. Keypad Commands

1. The SMS shall support keypad commands. Keypad commands shall be up to Nine digits in length. Keypad commands shall be entered at a keypad connected to an iSTAR controller and shall be used to activate system events. The event shall be configurable to activate any allowable event action.
2. Keypad Commands shall support Personnel Permission options to accompany the command and validate the issuer’s identity. Keypad Commands shall be configurable to require a valid credential or a valid credential plus a PIN. Keypad Commands shall also be available to all Personnel or only selected Personnel as part of a Personnel Group.
3. The SMS shall support the assignment of certain users as Keypad Command Administrators. These users shall be able to issue all Keypad Commands and shall not be required to be part of a Personnel Group assigned to a Keypad Command.

4. Keypad commands shall have the ability to be limited to specific doors as part of a Door Group within an iSTAR Cluster. In addition, specific readers shall be configured to allow or disallow keypad commands.
 5. Keypad Commands shall support segmentation of the nine-digit code in the form of Prompt Codes. Prompt Codes shall allow the user to utilize some digits of the Keypad Command to correspond to a command such as a door unlock, and the remaining digits to correspond to an object such as a door. When using Prompt Codes, the first segment shall be entered and the SMS shall prompt the user on the reader LCD module to enter the remaining digits. The SMS shall support two Prompt Codes per keypad command.
- V. RM Reader LCD Messages
1. The SMS shall provide custom LCD messages to be displayed on the LCD screen of RM readers. All messages, as well as date and time formats, shall be downloaded to the controller and will be used on all supported readers configured on that panel. The ability for the System Administrator to change the Language for LCD messages shall be provided. (The reader LCD supports Western character sets only. No double-byte languages are supported.)
- W. Wireless Reader Devices
1. The SMS shall provide for a Wireless Lock solution. The SMS shall interface to the wireless lock via panel interface modules. The panel interface modules (PIM) shall support a direct connect Wiegand or RS-485 interface to the Intelligent Controller.
 2. The SMS shall support up to 16 wireless readers per controller. The readers shall support communicating to a single panel interface module (PIMs) or up to 16 PIMs depending on reader type and physical location of reader.
 3. The SMS shall provide a Wireless Reader configuration tab within the Intelligent Controller UI for the setup of the RS-485 version of panel interface modules.
 4. The wireless reader editor shall support the following input configuration:
 - Wireless DSM
 - Wireless RTE
 - Wireless Reader Tamper
 - Wireless Reader Communication Fail
 - Low BatteryThe wireless reader editor shall support the following output configuration:
 - Door Latch Relay
 5. The SMS shall also support a Wiegand interface module to communicate to the iSTAR and apC family of controllers as a standard Wiegand reader signal.
- X. Door Configurations / Elevator Control
1. The SMS shall allow doors to be configured to operate in any of the following access control modes:
 - a. Unlocked
 - b. No Access (Secure mode)
 - c. Any combination of the following, as defined by schedule, event: card only, PIN only, Card + PIN, Card entry through keypad.
 2. The SMS shall allow a door to be configured to operate using the following functions:
 - a. Readers shall read cards while the door is in the open position.

- b. Door lock relay shall automatically lock upon the door being opened.
 - c. Allow for a user-defined delay relock time period.
 - d. Allow for a user-defined door unlock time and door held open time.
 - e. A separate (alternate) shunt timer for ADA flagged cardholders
 - f. The operator shall be able to specify a shunt expiration output to be triggered for a configurable time (in hh:mm:ss) before the expiration of the door open or alternate shunt. Can be enabled for ADA only, or all the time.
 - g. Allow for a user-defined door unlock and door held time, in seconds.
 - h. PIN-only access (keypad).
 - i. PIN-entry on the reader keypad shall be required during a specified schedule after a card access (unless a manual action or event has disabled PIN).
 - j. Card entry through keypad.
3. The SMS shall allow each door to be configured to cause a variety of events such as alarms to occur based on activity at that door.
 4. The SMS shall support the activation of an event after a user-defined number of consecutive cards are rejected at a door. A user-configurable timer shall be available to determine the time-frame for the consecutive rejects. The timer shall restart after a valid card read. Separate triggers shall be available for inbound and outbound directions on doors with in and out readers.
 5. The SMS shall support configuration of unlimited elevators.
 6. The SMS shall support an extended unlock function initiated via two valid card presentations to a single reader or a 'double swipe'. The double swipe feature provides the ability to designate doors at which cardholders with double swipe privileges may perform an extended lock or unlock of the door. The double swipe feature shall support the following:
 - a. Toggle mode – the first double swipe shall unlock the door and the second shall relock it. Toggle mode shall support the assignment of a cardholder group that can perform the double swipe.
 - b. Cardholders shall be required to have proper clearance to perform double swipe action.
 - c. Each SMS door shall be uniquely configurable for double swipe.
 - d. Reset of a double swipe unlock (relock) via a scheduled event.
 - e. Event activation to reflect double swipe state (Lock, Unlock).
 - f. Modified reader beeper pattern to reflect the extended unlock mode.
 7. The SMS shall support a two-person mode for unlocking certain doors – two-person mode shall require two cardholders to present valid cards to unlock a door. Two-person mode shall support the assignment of separate cardholder groups for each cardholder that can perform the unlock. (Two person mode shall only be available on doors connected to iStar Ultra Controllers)

Y. Maintenance Mode

1. The SMS shall support a Maintenance Mode to facilitate the installation, testing and maintenance of selected SMS objects. Maintenance Mode shall be used to limit information about an object displayed on the SMS Monitoring Station. An SMS System Operator, with the appropriate Privileges, shall be able to place SMS objects into Maintenance Mode. Placing an object into Maintenance Mode shall not prevent SMS actions associated with that object from occurring. Maintenance Mode shall only affect the Monitoring Application and

- shall allow the System Operator to:
- a. Only view those objects in Maintenance Mode
 - b. Exclude those objects in Maintenance Mode from an Operator's view
 - c. View information about all System objects, including those in Maintenance Mode
2. Operator Privilege and Application Layout Filtering assignments shall determine whether or not an object in Maintenance Mode is viewable as being in Maintenance Mode on the Monitoring Station. Only Monitoring Station operators with the correct privilege and Application Layout Filtering shall be able to view objects in Maintenance Mode. Maintenance Mode shall only be reported in Journal messages when an object is placed in Maintenance Mode.
3. The following objects shall be supported in Maintenance Mode (at a minimum):
- | | |
|-------------------------|--------------------|
| a. iSTAR Clusters | h. Elevators |
| b. Controllers | i. Events |
| c. Doors | j. Areas |
| d. Readers | k. Intrusion Zones |
| e. Input/Output Modules | l. Keypad Commands |
| f. Inputs | |
| g. Outputs | |
- X. Area Control and Antipassback
1. The SMS shall support the ability to define Area configurations. Areas are defined as physical regions bounded by doors. An area shall consist of a room, a specific location(s) within a building, or an entire building
 2. All configured areas shall have in/out access doors providing the ability to run reports showing all present cardholders in each area. There shall be no way to leave an area without presenting a credential to a reader/door.
 3. The SMS shall support Global Antipassback and shall allow an area to be configured to cross multiple clusters (groups of controllers) to enforce Global Antipassback decisions.
 4. The SMS shall provide the ability to run a Roll Call report. The host shall maintain a current area for each personnel record, and the time at which the area was entered (AreaAccessTime). The current area shall represent the last area entered by the cardholder based on a valid admit.
 5. The SMS shall support Area control to provide the ability for tracking personnel. With this function, an operator shall obtain the current location of cardholders. Dynamic views and or reports can be generated to show specific cardholders who are present in each defined area.
 6. Each cardholder's record shall provide easy access to view and maintain their current area location. This card record property will be updated as a person moves from one area to another using a valid credential.
 7. The SMS shall support the configuration of an area as a Mustering area. A Mustering area is an area where Personnel gather in an emergency. A Roll Call report shall be supported for the tracking of Personnel present during an emergency. The SMS shall also support the definition of a De-Mustering area. The De-Mustering area shall be used to place all Personnel in a neutral area to accurately track Personnel as they re-enter a facility.
 8. The local controller shall provide the ability to manage and control the Area configuration in the event that it loses communication with the SMS system server.

9. The SMS Area configuration shall have three modes of operations: None, Antipassback, and Timed Antipassback.
10. Antipassback shall control access based on the cardholder's location. The SMS shall deny access to cardholders who are in violation of antipassback rules. In the event that a cardholder leaves an area without presenting their credential to the out access reader/door and then tries to enter back into the area by swiping the In access reader/door, a denial of access will occur. The SMS shall provide the ability to grace individual cardholders who have violated antipassback rules. The Grace option shall also provide the ability to grace all cardholders.
11. Antipassback shall continue to be enforced during communications failure. SMS controllers shall have the ability to be clustered in a group. The master controller in the group and all other controllers within that group shall have full access to the existing antipassback information. The cluster can be configured for 'No Access' Communications Failure mode or for 'Local' Communications Failure mode.
12. Clustered controllers configured in 'Local' mode that are disconnected from the master controller shall grace all cardholders from antipassback violations. The disconnected controller shall then follow antipassback rules specific to the areas defined on that controller. If the controller does not know if a cardholder is in antipassback violation based on areas that are configured between controllers, access will be granted.
13. Clustered controllers configured in 'No Access' mode that are disconnected from the master controller mode shall not grace all cardholders from antipassback violations. All cardholders will receive a denial of access until communications is restored.
14. The SMS shall support Timed Antipassback. Areas configured for Timed Antipassback shall require a cardholder use an exit reader to exit an area. Cardholders who do not exit properly shall be required to wait for a predetermined period of time before re-entering the area.
15. The SMS shall support Pass-through Areas. Area Pass-through shall serve to restrict the length of time that Personnel can remain in an Area before being required to exit or pass through to another area. The SMS shall support a user-defined time period for the Pass-through area. Personnel Groups shall be configurable with Pass-through Restrictions and each Personnel Group shall support a separate, user-defined time period that may be different than the Area-wide time interval. Personnel Groups shall be configurable to be exempt from Pass-through Restrictions.
16. The SMS shall provide occupancy restrictions for areas. Restrictions shall be applied to individual cardholders (personnel) or user defined groups of cardholders. Areas shall be configurable to provide limits for the maximum and minimum number of personnel who can access an area at one time. It shall be possible to trigger an event based upon a violation of either of these rules. Events shall be configurable based upon the following criteria:
Maximum occupancy status
Minimum occupancy status
Group Maximum occupancy status
Group Minimum occupancy status
Personnel Count (user-defined)
Violation status (Antipassback entry/exit violation etc.)
17. The SMS shall support Soft occupancy restrictions for both maximum and minimum occupancy to allow reporting of violations while still allowing access to the area.
18. The SMS shall support Area Lockout. Area Lockout shall restrict or lockout certain cardholders from an area once they have accessed another area. The cardholder shall be

locked out of the designated target Area or Group of Areas for a specified period of time. The maximum time period for lockout shall be five (5) days. The target locked-out Area shall be any of the following:

Same Area

Another Area

Area group

19. The SMS shall allow a System Operator with the appropriate privileges to cancel the lockout time (lockout grace) for all or individual cardholders, thereby canceling the area lockout.

AA. Dynamic Area Manager

1. The SMS shall support the Dynamic Area Manager feature. The Dynamic Area Manager feature shall allow the first qualified person admitted to the Area to act as the Area Manager. This person shall be the first to enter the area and shall be required to be the last to leave the area.
2. An area designated for the Dynamic Area Manager feature shall have an entry reader and an exit reader.
3. The SMS shall deny any exit request from the area manager until all other occupants have left the area.
4. The Dynamic Area Manager feature shall support the use of the Conditional Access feature for the designated area.
5. The Area status display shall show the following Personnel counts:
 - Area Manager count
 - Managed Personnel Count (All Personnel admitted after the Dynamic Area Manager)
 - Conditionally Admitted Personnel Count

BB. Carpool Antipassback

1. The SMS shall provide Carpool Antipassback to facilitate parking lot area controls. Carpool Antipassback shall support the organization of Personnel into Carpool Groups which shall be permitted to park in designated Carpool Areas. The SMS shall move Carpool Groups in and out of Carpool areas based upon the driver's credential. The Carpool Antipassback feature shall allow the monitoring of vehicle counts in the Carpool Area to facilitate parking lot area Occupancy Restrictions. The SMS shall support Timed Antipassback for Carpool Antipassback areas.

CC. Escorted Access

1. The SMS shall provide an Escorted Access feature that gives the ability to control, track, and report on the movements of Personnel designated as Escorted Visitors. An Escorted Visitor shall be a visitor who can only move around a facility in tandem with an employee designated as an Escort.
2. There shall be two Escort Visitor modes: Companion mode and Remote Escort Mode. In Companion mode the system shall allow multiple Escorted Visitors to be accompanied by one escort. In Remote Escort mode the system shall allow Escorted Visitors and the Escort to present their credentials on opposite sides of a door to gain access.
3. The SMS shall have the ability to configure a designated Area to allow an Escorted Visitor to enter/exit the area without an Escort.

DD. Conditional Access

1. The SMS shall support Conditional Access that shall allow an occupant on one side of a door

- to grant temporary access to a cardholder who does not have clearance and was denied access to that door.
 2. The SMS shall support the configuration of an event to be used to notify the occupant that a cardholder is attempting to gain access through the door.
 3. The SMS shall support the configuration of a second event to be used to unlock/grant access to the door based upon a response from the occupant or a privileged SMS Operator.
 4. The Conditional Access function shall support an Operator configurable timer that shall be used to cancel the Conditional Access request if the occupant is unavailable or chooses to deny access
 5. The SMS shall support the use of Conditional Access in conjunction with the Dynamic Area Manager feature.
- EE. After Hours Enabling Reader
1. The SMS shall support an After Hours Enabling Reader that shall be used to allow a cardholder access to a group of readers during off hours.
 2. The SMS shall support the definition of a group of readers (the After Hours Reader Group) that shall be disabled during a pre-defined after hours period.
 3. The SMS shall support the definition of a schedule to be assigned to the after hours reader group defining the time the readers shall be disabled.
 4. The SMS shall allow a cardholder access to all readers in the after hours reader group once the cardholder presents a card at the enabling reader.
 5. The SMS shall require the cardholder to have proper clearance for any reader before granting access.
- FF. Intrusion Zones
1. The SMS shall support the configuration of Intrusion Zones. An Intrusion Zone is a user-defined group of Doors and Inputs on the same local Controller that delineates a physical area. This area shall be monitored and produce an alarm during any violation of the objects associated with the Zone.
 2. The local controller shall provide the ability to manage and control the Intrusion Zone in the event that it loses communication with the SMS system server.
 3. The Intrusion Zone shall have 2 modes of operations: Armed or Disarmed. When an Intrusion Zone is in an armed mode, the state of the Intrusion Zone shall either be Violated or Not Violated based on the state of the inputs and doors associated with the Zone. If the Zone is violated the SMS shall provide the ability to execute any defined event(s) within the SMS.
 4. The SMS shall provide the ability to display the “Ready to Arm State” of any configured Zone. The “Ready to Arm State” shall be able to be displayed from any SMS monitoring application or from a local reader with an LCD display. All off-normal points/doors shall be able to be displayed from both locations. If any point or door associated with a Zone is not in a normal state, the Zone shall show a “Not Ready to Arm State”.
 5. When a door is placed in a Zone, the operation of the door shall be configured based on the state of the Zone (unlocked, locked, secure). Specific doors assigned to the Intrusion Zone shall be configured as entrance or exit points for the Zone. When the Zone is being armed or disarmed, a user-definable time shall be set for exit or disarm operations. Specific readers/doors shall have the ability to be defined as arm/disarming stations.
 6. The Intrusion Zone shall be configured such that when an input configured in a Zone is active, the Zone cannot be armed without executing a force arm. When a Zone is force

armed, the input(s) that were in an active state shall not function as part of the Zone until they are placed back in a normal state and the Zone is disarmed and rearmed.

7. Inputs configured in a Zone shall have the ability to be configured as Controlled Inputs or Monitored Inputs. A Controlled Input shall follow the state of the Zone. If the Zone is disarmed, the Controlled Input shall be disarmed as well. A Monitored Input shall have the ability to cause a Zone violation even if the Zone is in a disarmed state.

GG. Schedules

1. The SMS shall support unlimited operator configurable schedules. Each schedule shall allow unlimited individual time intervals.
2. Each system controller shall support a minimum of 128 schedules and a minimum of 18 time intervals per schedule.
3. Each schedule shall consist of operator-defined time segments. Each time segment shall be day(s) of the week and include holidays and starting and ending times. The system shall provide grouping of days.
4. Recurring schedules shall be supported and provide hourly, daily, weekly, bi-weekly, monthly, quarterly, annual and semi-annual intervals. Recurring schedules shall support a start date and shall be configurable to end by a certain date or after a pre-defined number of occurrences.
5. Recurrence patterns shall be supported to allow:
 - a. Schedule recurs every X year(s)
 - b. Schedule activates on the last day of each month
 - c. Schedule activates on the specified day of each month
 - d. Schedule activates on the first, second, third etc. weekday of each month

HH. Holidays

1. The SMS shall support unlimited holidays.
2. The SMS shall support holiday type designations as Recurring Day of Month, Recurring Relative Monthly, Non-Recurring or Day of Week. The SMS shall allow assignment of duration to each holiday.
3. Holiday groups can be assigned to a Schedule.

II. Time Zones

1. The SMS shall maintain time zones to be used when configuring certain system objects. A time zone shall adhere to standard international Time Zone behavior, and the system shall support all time zones supported by the Windows OS.
2. The SMS shall allow time zones to be assigned to IP devices, controllers, CCTV matrix switchers, DVRs, and scheduled Manual Actions.

JJ. Clearances

1. The SMS shall support configuration of unlimited Clearances.
2. The iSTAR controllers shall support up to 150 clearances per person except for the iSTAR Ultra controller, which shall support up to 1000 clearances per person.
3. The SMS shall support clearance activation and expiration date and time.
4. The SMS shall support unique activation and expiration dates and times for clearances for each Cardholder. (This functionality requires the iStar Ultra Controller)

5. The SMS shall support the ability to select multiple personnel from a Dynamic View and assign clearance(s) to the selected personnel.
6. The SMS shall support the ability to select multiple personnel from a Dynamic View and remove clearance(s) from the selected personnel.

KK. Custom Clearances

1. The SMS shall support the configuration of up to 20 Custom Clearances per Personnel record and up to 100,000 system-wide. Custom clearance shall give unique individualized access to Doors/Door Groups and Elevators/Elevator Groups during an assigned schedule. The SMS Custom Clearances shall also support the assignment of activation and expiration dates.
2. The SMS shall support a process to remove expired custom clearances from personnel records. The process shall be configured as a system-wide event action with the option to activate by schedule.

LL. Clearance Filters

1. The SMS shall support Clearance Filters. Clearance Filters shall provide the ability to dynamically change the access rights of personnel (cardholders) or groups of personnel. Personnel with a lower Clearance Filter level than that assigned to a card reader shall be denied access to that card reader (door). Clearance Filter levels shall be assignable to card readers either manually or automatically via event logic or a time schedule.

MM. Events

1. The SMS shall support unlimited operator configurable events, including the scheduling of events, and action-based trigger of events.
2. The system shall provide 8 configurable event priority levels with a total of 200 numbered event priorities. The system shall allow the operator to define custom colors and labels per individual priority level.
3. The system shall allow an event to be configured to:
 - a. Be sortable by event name, date/time, priority, state, and any other displayable information.
 - b. Be routed to operators by operator privileges, including support for the routing by time of day feature.
 - c. Require or not require operator acknowledgment.
 - d. Require or not require operator clearing.
 - e. Require or not require a log message to be entered by the system operator acknowledging the event.
 - f. Require or not require a log message to be entered by the system operator clearing the event.
 - g. Display or not display the event activation.
 - h. Require the object(s) causing the event activation to reset before the operator may acknowledge the event.
 - i. Display an operator-defined text message upon event activation.
 - j. Display an operator-defined text message when the event is deactivated.
 - k. Be associated with a map so the map opens automatically on the monitoring station when the event activates.
 - l. Activate a second event when the first event activates and is unacknowledged for a specified period of time.

- m. Activate a second event when the first event activates, is acknowledged and is not cleared for a specified period of time.
 - n. Allow the operator to associate an audio wave file with the event.
 - o. Allow for minimum activation time and delayed activation time for events.
 - p. Download events to the iSTAR controllers.
 - q. Run imports and exports.
 - r. Run reports and remove report results.
- 4. Event Instructions: Each event shall support event instructions to be displayed in the Event Details Screen. Event instructions shall support a maximum of five hundred characters and shall support website addresses, UNC addresses and local file paths.
- 5. Latch, Unlatch, Toggle, and Pulse for Event: The SMS shall support Event Actions and Manual Action buttons that can be used to Latch, Unlatch, Toggle, and Pulse other Events.
 - a. The SMS shall support a “Latch” Event Action which shall cause it to activate and remain activated.
 - b. The SMS shall support an “Unlatch” Event Action which shall cause it to deactivate and remain inactive.
 - c. The SMS shall support a “Toggle” Event Action which shall reverse an Event’s Latch-Unlatch state: switching a Latched Event to an Unlatched Event and vice versa.
 - d. The SMS shall support a “Pulse” Event Action which shall cause an event to activate momentarily.
- 6. The SMS shall allow an operator to create a copy of an existing event from within the event editor.
- 7. Event Assessment:
 - a. The SMS shall provide an Event Assessment Feature which allows an operator to quickly view all objects associated with an event in a user defined Event Assess Application Layout.
 - b. The SMS shall not require the operator to navigate away from the event assessment window to review objects associated with the event.
 - c. The SMS shall provide an Event Editor “Assess Configuration” to allow an operator to configure the objects available during the assessment of an event in the Monitoring Station.
 - d. The Assess Event Application Layout shall have the following capabilities:
 - (1) View any documents associated with the Event.
 - (2) View live video associated with the Event.
 - (3) View recorded video associated with the Event.
 - (4) View Event details.
 - (5) View a Map associated with the Event.
 - (6) View a Journal Replay of the event, based on a query associated with the Event.
 - (7) Use an Event Details Viewer with additional quick action buttons to process the Event.
 - e. Each event shall provide the ability to show the entire Event Assessment with a single mouse click via an icon.

- f. The event assessment layout shall only be available for viewing by operators with appropriate privilege.

NN. Dual Phase Event Acknowledgement

1. The SMS shall have the capability of configuring user defined events (alarms) to require Dual Phase Acknowledgement. Dual Phase Acknowledgement shall provide a Pending Acknowledgment window and a Pending Clear event monitoring window in addition to the System Activity window. Each event in the SMS shall be configurable individually to use Dual Phase Acknowledgement. Once the event is acknowledged, it shall be removed from the Pending Acknowledgment window and shall appear in the Pending Clear event monitoring window. A monitoring station operator with the appropriate privilege to clear events can select the event from the pending clear event monitor window and click the clear event button to clear the event. Events that require clearing and are waiting to be cleared shall be configurable to require acknowledgement upon re-activation of the event.
2. Events configured for Dual Phase Acknowledgement shall have the following features:
 - a. The event shall be configurable to require a log message for alarm acknowledgement and or alarm clearing.
 - b. Predefined log messages shall be assignable to alarm acknowledgement and or alarm clearing.
 - c. The SMS shall support the configuration of an Operator's monitoring station permissions to determine if the operator can only acknowledge events, only clear events, or can acknowledge and clear events.
 - d. Operators with acknowledge and clear privileges shall be able to acknowledge and clear events in a single action.
 - e. A Dual Phase Acknowledgement event shall be configurable so the acknowledging operator can't clear the event. (In this configuration, clearing the event shall be required by a different operator.)
 - f. Events that are acknowledged or silenced shall be configurable to remain silent until cleared.
 - g. A user-defined timer can be configured to activate a second event if acknowledgement of an event, or clearing of an event, does not take place within the specified time frame. The timer shall start when the event is activated.

OO. Sounds

1. The SMS shall include a Sound editor that allows an operator to create Sound objects to associate with 'Play Sound' Actions for Events. A single Sound object may be associated with multiple Events, rather than having to save an individual sound file multiple times—each associated with a single Event.
2. Sounds shall be saved in a Sound table in the SMS database.
3. Sounds shall replicate, on an enterprise system, but they will be Local Only.
4. The SMS shall support the ability to import and export Sounds in .WAV file format. The size of the .WAV files that are imported shall be enforced to be less than 1460000 bytes (1.39 MB).
5. Sounds shall be Privilege based.

PP. Journal Triggers

1. The SMS shall support a Journal Triggers editor that allows an operator to define Triggers to activate an Event when a specified Journal Message occurs. The Journal Trigger shall be a

Query-like object that evaluates Journal Messages and pulses an Event when the criteria specified in the configured trigger is logged in the Journal.

2. The SMS shall support an Event Action that sends email notification with a description of the activation cause each time a Journal trigger is activated.
3. The SMS Monitoring Event Status screen shall display the reason a particular Event was pulsed by a Journal trigger.
4. The SMS shall support up to a maximum of 500 Journal Triggers.

QQ. Audit Triggers

1. The SMS shall support an Audit Triggers editor that allows an operator to define Triggers to activate an Event when a specified Audit Log Entry occurs. The Audit Trigger shall be a Query-like object that evaluates Audit Log Entries and pulses an Event when the criteria specified in the configured trigger is logged in the Audit Log.
2. The SMS shall support up to a maximum of 500 Audit Triggers.

RR. Manual Action Challenge

1. The SMS shall support Manual Action Challenges. The Manual Action Challenge shall require a SMS operator to enter their login credentials (User name and password) when executing a manual action from within the SMS.
2. The Manual Action Challenge shall be available from both the Administration and Monitoring Applications.
3. The Manual Action Challenge shall be assigned to a Privilege and the Privilege shall be assigned to the SMS operator.

SS. Document Editor

1. The SMS shall support the ability to import multiple types of document objects to include: PDF, TXT, XML, DOC, XLS, JPG, GIF, PNG, TIF
2. The SMS shall have the ability to attach these object types to the following areas:
 - a. Personnel records to provide additional information.
 - b. Events as part of the Events Assessment Feature.
 - c. A Guard Tour

TT. Integrated Email

1. The SMS email system shall have the ability to interface directly to an SMTP-compliant email system supplied and configured by the user.
2. The email configuration shall support user authentication via a password and SSL encrypted communication to the email server.
3. The email system shall support the ability to send emails to Personnel Groups.

UU. Import / Export

1. The SMS shall provide a means for manually importing and exporting selected data in XML format. This mechanism shall support the import and export of any and all classes or types of data in the system. Specific data validation and logging requirements shall be met.
2. The system shall also support importing from CSV files.
3. The SMS shall provide an automated import mechanism (preferably XML-based). This mechanism shall support the import of most classes or types of data into the system. Specific data validation and logging requirements shall be met.

4. The SMS shall have the capability to perform automated imports from an Open Database Connectivity (ODBC) data source allowing the import of personnel data directly into the system database.
5. The system shall have the ability to connect to a directory service source via the Lightweight Directory Application Protocol (LDAP). The connection to the LDAP source shall be user-configurable directly from the SMS and shall not require custom code. The LDAP interface shall also support the automatic assignment of SMS clearances based on data contained in the LDAP record. The LDAP feature shall support the following features:
 - a. LDAP server name and user-defined port number.
 - b. A base distinguished name for the root of searches.
 - c. A user-definable LDAP search filter to refine object search.
 - d. User-defined mapping of attributes to SMS personnel fields.
 - e. The use of a Distinguished Name (DN) entry for the SMS to authenticate to LDAP.
 - f. Option to search all sub-levels of the directory from the base DN.
 - g. Preview sample-data based on SMS LDAP import settings.
 - h. Automatic roles-based SMS clearance(s) based on two fields of source data.
 - i. Automatic import of directory entries from the LDAP source.
 - j. Authentication via a user-definable LDAP user account and SSL.
 - k. Automatic SMS clearance assignment.
6. The SMS shall provide a Data Mapping feature that provides field mapping information using the XSLT file based on the input data or an external XSLT file.
7. The SMS shall support Import and management of Operators with their respective Privilege Groups using XML and LDAP role-based templates.

VV. Objects

1. Each object within the SMS shall be addressed by a unique operator-defined name. Object names shall be unique within object types.
2. The SMS shall provide the ability to add description text to each object definition.

WW. Reports

1. The SMS shall support a Report Service that runs as a Windows Service. The Report Service shall operate in either 64 or 32 bit mode. The Report Service shall execute Reports that are either run on the Server by an Operator or configured to run automatically as an Event Action.
2. The SMS shall provide configurable data reports for database configuration, historical activity (Journal) and audit tracking. Pre-defined reports shall be available for download and import into the system.
3. The SMS report function shall perform the following:
 - a. Create reports about any object.
 - b. Create report templates to simplify report design.
 - c. Run reports on demand.
 - d. Save report results for sharing between different users of the application.
 - e. Export reports into formats such as PDF, RTF, TXT, TIFF, Excel (XLS), and MHTML.
 - f. Specify a query to select and filter the records on which to report.

- g. Specify the data fields to be included in a report.
 - h. Specify a design for the report layout.
 - i. Design a report form to be used as a layout for headers / footers for multiple reports.
 - j. Access and use system pre-defined report forms.
 - k. Select tabular, multi-line, or free form report layouts.
 - l. Report on objects linked together with parent / child relations.
 - m. Schedule reports to run automatically on a customized schedule.
 - n. Send exported report files to the printer or to external recipients via e-mail.
- 4. The SMS shall support integration to The Business Intelligence Reporting Suite (BIRS). The suite shall offer web-based reporting as well as data warehousing of SMS historical and system data. The suite shall include multiple pre-written reports such as 24 Hour Journal Messages, 24 Hour Trouble Messages, Graphical Usage and Count of Door Group. The open system procedures shall allow the reports to be written and saved for repeat use.
 - 5. The reporting suite shall provide an interactive user experience via any standard web browser, allowing the user to scrutinize the information without needing to print or review hard copies.
 - 6. The reporting suite shall support connecting to one or more SMS systems. This shall provide data and reports across an enterprise solution to allow segregated reports that reflect both satellite application server data as well as master application server data.
 - 7. The reporting suite shall allow an enterprise to share and blend data from other sources such as ERP and Time and Attendance systems to yield critical business information and reporting.
 - 8. The reporting suite shall provide information delivery options such as email, CSV export, PDF export, XML data transfer, or database pool offerings. The suite shall also be a critical resource in system review and audit procedures such as system maintenance and performance.
 - 9. The Reporting Suite shall:
 - a. Provide Intuitive user interface and web-based reporting for SMS customers
 - b. Share and blend data from other sources to yield critical business information
 - c. Leverage Microsoft® Business Intelligence (BI) tools
 - d. Include Reporting Service for report delivery and presentation
 - e. Perform Reporting and processing from the SMS host
 - f. Include Subscription options for automated delivery of reports
 - g. Include Dashboard, graphical, and statistical reports, and reports customized by user
 - h. Generate Reports on any PC with compatible Web browser without SMS Client software
 - i. Offer and secure Data via Active Directory and SQL permissions
 - j. Include Optional front end or other application integration including SharePoint

XX. Dynamic Views

- 1. The system shall support a grid format displayable report that will be usable to display homogeneous lists of objects within the system. This display shall be configurable both at configuration time and also at run time.
- 2. The Dynamic views shall have the following features:

- a. Real-time updating and display of property values.
- b. The display shall be sortable.
- c. Groupable by any number of columns.
- d. Filterable based on user selectable criteria.
- e. Printable.
- f. Can be saved as a MS Excel file from the current view.
- g. Exportable in either XML or CSV file formats.
- h. The export file shall be viewable in Excel (Excel must be installed separately).
- i. The export file shall be able to be emailed.
- j. The user shall be able to add and remove columns from the grid at runtime to enhance the user experience even if displaying a preconfigured view.
- k. The view shall be capable of pre-configuration so that repeatable displays of objects are possible.
- l. The view shall support in-place editing of properties of the object.
- m. Bulk operations shall be performed via multi-selection. The operations shall consist of (but are not limited to) setting a property to a value and deletion.

YY. Query

1. The SMS shall provide a Query engine to be useful for users without any knowledge of SQL or any other specific query language. It shall allow users to make requests against data sets with preconfigured relations between tables. The relations shall reflect the actual relations between database objects and the user shall be able to put conditions on any available field in the selected object type and its subordinate objects.
2. The users shall be able to construct a proper query expression selecting all available operations, column names, and table names from prompted lists. It shall eliminate the necessity to memorize any particular expression syntax. References to existing configuration objects shall also be prompted through a list of existing objects where applicable, eliminating the necessity of memorizing names. The Query feature also shall support complex logic, such as AND/OR.
3. Negative logic Queries using the new NOT IN operators
The SMS shall support Query filters that perform AND/OR operations to narrow Query results. The SMS shall also support building complex query operations by use of block filters that perform AND/OR/AND NOT IN/OR NOT IN operations to further narrow Query results.
4. The SMS shall provide a Journal Query Assistant as a special method of the Query engine to query on XML fields within Journal Messages. This method shall allow the user to build queries on Journal messages. The Journal Query Assistant shall support Card Admitted, Card Rejected, Operator Login and Operator Activity message types, Area Activity, Object Changed State and Manual Action message types.

ZZ. Guard Tour

1. The SMS shall support Guard Tours.
2. A Guard Tour shall consist of a series of predetermined Stops requiring a Guard to check-in at each Stop to complete the Tour within the specified time. The Guard Tour shall consist of any combination of Doors, Elevators, and Inputs.
3. The SMS shall support a maximum of two hundred Guard Tours.

4. The maximum number of Stops per Guard Tour shall be one hundred.
5. The SMS shall support up to a maximum of fifty simultaneous running Guard Tours.
6. The SMS shall support two types of Guard Tours: Sequential and Random requiring the Guard to check all Stops in sequence or in a random order.
7. A sequential tour shall be configured with a minimum and maximum time that a guard shall have between stops.
8. Each Tour shall be configured with a specific group of guards that shall be allowed to execute the Tour.
9. The following Tour states shall be available to activate preconfigured events in the SMS:
 - a. Activated
 - b. Started On Time
 - c. Started Early
 - d. Started Late
 - e. Suspended
 - f. Suspended too Long
 - g. Resumed
 - h. Cancelled
 - i. Completed
 - j. Completed Early
 - k. Completed Late
 - l. Inactive
 - m. Not completed On Time
 - n. Failed To Start
 - o. Error Occurred
10. A guard Tour shall have the ability to be initiated from:
 - a. The reader configured as the first Stop of the Tour
 - b. An Event (Manually activated or on a Schedule)
 - c. A manual Action from an Operator at the SMS Monitoring Workstation
11. The SMS shall support sending an email notification to a Guard of the impending start of the scheduled Tour.
12. A Guard shall be required to complete check-ins at all Guard Tour Stops before the maximum completion time expires and shall be required to spend at least the minimum amount of time on the Tour.
13. A Tour shall be canceled by either an error, event action or a manual action from an Operator at the SMS Monitoring Application.
14. Each Tour shall be able to be configured with a minimum and maximum time of completion.
15. The system shall indicate that a Tour Stop was reached early and started early if a guard checks in at the first stop before the minimum stop time expires.
16. The system shall indicate that a Tour Stop was reached late when a guard checks in at the first Stop after the maximum time expires.

17. The System shall indicate that a Tour Stop was not reached on time when a guard has not checked in after the maximum Stop time expires.
18. In the SMS Monitoring Station Application, it shall be possible to display the details of all the Guard Tour Stops and the current status of the Tour.
19. Each Guard Tour shall have the ability to attach up to a maximum of ten documents explaining the details of the configured Guard Tour.
20. Each Guard Tour shall support Predefined Log Messages or Message Groups.
21. Tour status shall be available from the SMS Monitoring Station Application and shall provide the following information:
 - a. Tour Type
 - b. Last Tour Status
 - c. Current Tour Status (Running/Not Running)
 - d. Guard Name (if active)
 - e. Last Completed Stop
 - f. Percentage Completed.
22. The SMS shall provide the ability to configure an icon on an SMS MAP representing a Guard Tour. An Operator shall have the ability to start the Tour and manually assign a specific Guard responsible for completing the Tour from the MAP.
23. The icon representing the Tour shall change appearance based upon the current state of the tour.
24. The SMS shall provide the ability to run a Journal Report providing the details of any completed or active Tour including:
 - a. Time scheduled
 - b. Guard assigned
 - c. Activation time
 - d. Stop status

AAA.Hand Held Reader

1. The SMS shall support a portable hand-held reader that shall provide identity verification. The portable hand-held reader shall support the following:
 - a. The portable hand-held reader shall work on an Android device
 - b. This android device shall support Bluetooth communication to three types of Multi technology readers.
 - c. The readers shall be capable of reading:
 - (1) HID Proximity and iCLASS SE PACS data
 - (2) HID Proximity and custom MIFARE sector with key
 - (3) HID Proximity and (Mifare, Desfire) csn
 - d. Act as a single door controller much like a conventional door in online or offline modes. Offline modes shall support the following functions:
 - (1) Offline mode shall support 100,000 cardholders
 - (2) All card transactions shall be stored locally and uploaded to the SMS when the unit is placed online.
 - (3) Offline mode shall support storing 10,000 transactions

- e. Online mode shall support all cardholders in the SMS
 - f. Shall securely communicate to the SMS using web services (encrypted using TLS) supporting (3G/4G or Wi-Fi)
 - g. Allow Operators with appropriate permissions to log into the device using single sign on authentication
 - h. Specific cardholders shall be downloaded to the device based on clearance assignment
 - i. Shall have the ability to display
 - (1) access grant
 - (2) denial of access
 - (3) cardholders portrait
 - (4) card number
 - j. It shall be possible to set the amount of time that the display shows the last card transaction
 - k. Shall be available to download from the Google Play app store
 - l. Shall support phones and tablets running Android OS 5.0 and higher
2. Roll Call
- a. The portable hand-held reader shall be able to perform a Roll Call feature.
 - b. As cardholders present their cards at this mobile device, the SMS shall have the ability to remove the cardholder from their current area and place them in a muster area.
 - c. During a Roll Call, it shall be possible for an operator, from the SMS, to display a list of cardholders including their names and portraits in their respective areas.

BBB. Random Screening

- 1. The SMS shall support a Random Screening feature.
- 2. The Random Screening feature shall allow SMS doors to be configured to randomly reject cardholders for the purpose of identity verification or baggage searches etc.
- 3. The SMS shall allow each door to be configured with a percentage value to define the frequency of the random screening action.
- 4. The SMS shall provide a Random Screening event for each door that shall be activated when a cardholder is rejected for Screening. The event shall be used for notifying the proper Personnel of the Screening activity.
- 5. The SMS shall log all Screening activity for reporting or auditing purposes.

CCC. CCTV Integration / Digital Video

- 1. The SMS shall provide extensive integration with American Dynamics DVR/NVR solutions.
- 2. The SMS server shall be connected to the DVR/NVR during the configuration process enabling the SMS to query the DVR/NVR for setup information.
- 3. The SMS shall use tree controls to drag and drop video servers or cameras directly into the interface for intuitive and instantly active video integration.
- 4. The SMS shall provide live camera display during configuration.
- 5. The SMS shall provide the ability to drag cameras into tours.
- 6. The SMS shall provide the ability to identify and automatically configure all cameras on a controller.

DDD. General Purpose Interface

1. The SMS shall support a licensable General Purpose Bi-directional Serial Interface.
2. The General Purpose Interface shall be a programmable bi-directional communication protocol that shall provide a general mode of communication between the SMS General Purpose Interface driver and a third-party device.
3. The third-party device shall send pure ASCII messages via a serial port (RS-232) or remotely via a TCP/IP port (via a Terminal Server) into the General Purpose Interface driver.
4. The SMS shall interpret messages in two ways:
 - a. As journal messages recorded into the SMS historical journal.
 - b. As any of five Monitoring Point status changes configured to trigger an SMS event.
5. The General Purpose Interface supports the following functionality:
 - a. Input: where the input strings are sent from the device through the Serial/Network port to the SMS Server. The General Purpose Message Protocol object is used to define and parse the information.
 - b. Output: where the output is an Action and requests a response from the device.
 - c. Poll: where the poll is an action that requires a response from the device.

EEE. ID Badging Subsystem

1. The SMS shall include an embedded ID Badging Subsystem. The ID Badging subsystem shall utilize a common database with and be an integral part of the SMS. The ID Badging Subsystem shall provide the ability to capture cardholder images and design and print user-defined badge layouts. The Badging Subsystem shall support the following capabilities:
 - a. Unlimited number of badge design layouts.
 - b. WYSIWYG badge designer.
 - c. Background color detection in the portrait image.
 - d. Threshold level selection to apply to background detection.
 - e. User-defined selection of background color.
 - f. User-defined selection of replacement color or transparency setting.
 - g. Edge-detection setting, to aid in replacing only the selected background and not any matching color within the portrait image.
 - h. Capture, import, and display portraits.
 - i. Capture, import, and display signatures.
 - j. Capture and display fingerprints.
 - k. Insert, import, and display foreground and background images.
 - l. Print two-sided badges.
 - m. Encode magnetic data onto personnel badges.
 - n. Insert 1D or 2D bar codes.
 - o. Insert or replace color and transparent effects for image and background display.
 - p. Support a variety of image formats including .bmp, .jpg, .tif, and .wmf.
 - q. Custom functions using the Expression builder.
 - r. Multiple images per cardholder.
 - s. Diagonal and Square borders. Each type of border shall support a user-defined width and height setting, and individual color settings for each border side.

- t. Proper Case (first letter in string is set to uppercase, all other characters set to lowercase).
- u. Year display (four- or two-digit).
- v. Month display (full or abbreviated name, or numeric).
- w. Day display (full or abbreviated name, or week/month numeric).
- x. Hour display (12 or 24 hour format).
- y. Minute display.
- z. Second display.

FFF. Visitor Management

1. The SMS shall support an optional, embedded Visitor Management feature. The SMS shall support the creation and management of visitor appointments. The Visitor Management feature shall serve as a replacement for paper-based visitor log books and shall support the organization and tracking of visitors. The Visitor Management feature shall support the following features:
 - a. Keep track of visits (and Visitors) in progress
 - b. Single-/multi-visitor group appointment scheduling
 - c. Temporary credential issuance
 - d. Visitor check-in/check-out
 - e. Visit Templates
 - f. Visit Sites
 - g. e-mail notification of visitor arrivals
 - h. Manage unplanned visits and anonymous visitors
 - i. Manage the return of credentials and the end of a visit
 - j. Configure Instructions for the visit
 - k. Configure personnel as visit hosts
 - l. The capability to check-in and check-out visitors by presenting a valid card at a designated reader.
 - m. The ability to scan a license or a passport when adding a new visitor. Each field associated with a license or passport can be individually selected for import.
 - n. Run reports and queries on both scheduled or completed visits
2. The SMS shall provide the ability to schedule a nightly event that shall perform an automatic checkout of all visitors per partition.
3. The SMS shall support an optional Visitor Management Web portal that shall allow a host to create and manage visits and visitors via a standard web browser. The initial browser logon shall allow customization to display a unique name.
4. The SMS Visitor Management Web portal shall support the following Web Browsers:
 - Internet Explorer
 - Chrome
 - FireFox
 - Safari on IOS
5. An SMS Operator shall be able to perform the following Visit Site functions:
 - a. Create and Configure Visit sites

- b. Customize the Portal for each visit site
- c. Assign a custom image that represents the visit site
- d. Assign the visit site to a partition
- e. Create and configure visitor templates for a site (which can include Clearances for the Visit)
- f. Create and configure a Visit Template for a site
- g. Specify what fields are to be used when creating a new visitor in a site
- h. Individually select which fields are mandatory
- i. Add additional details to a visit site including user definable fields
- j. Designate which hosts can access a site to create a visit
- k. Assign a document to a visit site
- l. Configure the details for the welcome Email to hosts
- m. Configure a Visitor Management Door Action for card swipe check-in and checkout
- 6. A Host using the Visitor Management Web portal shall be able to do the following:
 - a. Create, edit and delete Visits
 - b. Utilize Visit Templates to create Visits
 - c. Search for existing Visits
 - d. Add instructions for the visit and attach pertinent documents to the visit
 - e. Add additional Hosts to a Visit
 - f. Create New Visitor records and add Visitors to Visits
 - g. Email all visitors and hosts associated with the created visit
- 7. The SMS shall support a Kiosk for self-visitor check-in
 - a. The SMS system shall support an unlimited number of Check-in sites. Each Check-in site shall be configured with a Kiosk application that operates on an iPad. This Kiosk application shall be used to allow a visitor to self-check-in as a new or pre-enrolled visitor. Each site shall have the ability to customize how the Kiosk Check-in application works. The Kiosk shall provide the following features:
 - b. Each Kiosk shall support the creation of custom messages for each check-in site:
 - (1) Welcome message
 - (2) Visitor not found message
 - (3) Check-in complete message
 - (4) Registration complete message
 - c. The Kiosk shall have the ability to accept unregistered visitors (Optional) via the following steps:
 - (1) Enter a new visit (First, Last, Email)
 - (2) Take a picture
 - (3) Enter and assign Host via context sensitive lookup that shall show the host name and image as you type
 - (4) Require acknowledgement of an NDA or other document (Optional)
 - (5) Automatically email host when check-in is complete

- (6) Automatically check-in visitor (optional)
- d. The Kiosk shall have the ability to add a Pre-enrolled visitor via the following steps:
 - (1) Find visitor by either Email Address or First/ Last Name via context sensitive lookup
 - (2) Take a picture
 - (3) Require acknowledgment of an NDA or other document (Optional)
 - (4) Automatically email host when check-in is complete
 - (5) Automatically check-in visitor (optional)

GGG.Access Management Workflow

1. The SMS shall support an Access Management Workflow feature including a Web Portal. This workflow shall allow different types of requests and approvals to automate the assignment of clearances. The following features shall be supported by the Access Management Workflow feature:
 - a. The creation of an unlimited number of Access Request Sites
 - b. Each access request site shall be uniquely configurable with the following:
 - (1) Show selected personnel fields from requesters
 - (2) Display General site information
 - (3) Show additional user definable fields
 - (4) Select authorized requesters
 - (5) Select available clearances
 - (6) Select Personnel for access request assignment
 - c. The Access web portal shall support the following:
 - (1) Customized portal name display
 - (2) Single Sign on authentication
 - (3) Creation of Access requests, which shall provide the following:
 - (a) Name of the request
 - (b) Available site clearance selection
 - (c) Justification statement
 - (d) Request Status
 - (e) Personnel associated with the request
 - (f) Attach a document relative to the request
 - (g) Ability to save the request without submittal
 - (h) Ability to submit the request
 - (4) Access approval with the following capabilities:
 - (a) List the assigned submitted pending requests
 - (b) Show all details pertaining to the request
 - (c) Ability to approve or deny the request
 - (d) Provide comments on the reason for the approval/denial
 - (e) Review the history (audit) of previously submitted requests
 - (f) Provide the ability to revoke a previously approved request

- d. The SMS shall provide the following Internal Request features:
 - (1) Clearances shall be configurable with the following approval rules:
 - (a) Auto approve
 - (b) Any approver from a partition
 - (c) Any selected approvers
 - (d) Only allow assignment via approved request
 - (2) Door activity shall also provide the ability to automatically generate an approval request which shall be:
 - (a) Subject to a schedule
 - (b) Subject to direction of the swipe (in/out)
 2. All generated requests shall viewable within the SMS showing current status and details.
- HHH.Smart Card / Proximity Card Enrollment
1. The SMS shall provide a smart card enrollment feature as part of the ID Badging Subsystem. The smart card enrollment feature shall allow a user to enroll MIFARE, iCLASS or DESFire cards utilizing a USB wedge reader or a Manufacturer-approved badge printer.
 2. The SMS shall provide a proximity card enrollment feature as part of the ID Badging Subsystem. The proximity enrollment feature shall allow a user to enroll the card number of proximity cards on a Fargo HDP 5000 printer that is equipped with an OMINKEY CardMan 5x25 encoder.
 3. The ID Badging Subsystem shall support the creation of Smart Card Templates to define the smart card configuration. Templates shall be used to define the data transfer between the physical card and the Personnel Record. Templates shall define the card type as MIFARE, iCLASS or DESFire. When programming a card, the system shall be able to read and write to all relevant data such as personnel fields, card fields or card formats. The Badging Subsystem shall provide the ability to Enroll MIFARE, iCLASS or DESFire. The Badging Subsystem shall provide the ability to Program and Enroll MIFARE.
 4. Templates shall also be utilized to define the Security Keys needed to access the data on the smart card. Templates shall be assignable to the enrollment device (wedge reader or printer).
 5. The ID Badging Subsystem shall support both the enrollment (reading of data from the card) and programming (writing of data to the card) for MIFARE cards. The ID Badging Subsystem shall support the enrollment of DESFire cards and shall support Card Serial Number data only. The ID Badging Subsystem shall support the enrollment of iCLASS cards and shall support Card Serial Number data only.
 6. The ID Badging Subsystem shall support the creation of Custom read/write Keys. Custom Keys are private keys supplied by a third party. Custom Keys shall be assigned to Software House Readers via Program Cards supplied by the Manufacturer.
- III. System Parameters (Based on a single credential per cardholder)
1. The SMS shall have a maximum capacity of:
 - a. 5,000 online readers
 - b. 20,000 online inputs
 - c. 20,000 online outputs
 - d. 500,000 enabled Personnel Records
 - e. 256 Simultaneous Clients (256 is a design capability while the tested limit is 100)

2. The SMS shall support a Master Application Server (Enterprise Architecture) with maximum capacity of:
 - a. 40 Satellite Application Servers (tested limit)
 - b. 500,000 Global enabled Personnel Records
 - c. 100 Simultaneous Clients
3. The SMS shall support an Enterprise Architecture (based on 40 SAS) with a maximum capacity of:
 - a. 200,000 online readers
 - b. 800,000 online inputs
 - c. 800,000 online outputs
 - d. 20,000,000 local enabled Personnel Records
 - e. 500,000 Global enabled Personnel Records
 - f. 20,500,000 Total enabled Personnel Records

2.4 OPERATION

- A. The SMS shall provide the following operational functionality:
 1. The system shall control access to a designated area.
 2. The system shall validate cardholder credentials by use of downloaded personnel records, card formats, PINs, biometric enrollment and multiple active cards. The system shall compare the time, location, and unique credential number of an attempted entry with information stored in memory.
 3. Access to a designated area will be validated only when a user's credential has a valid number for its facility and the number is valid for the current time and for the reader where it is used.
 4. The system shall access the hardware that validates the person and monitor the security of a building by use of controllers, doors, readers, elevators, inputs and outputs. When access has been validated, a signal to the door locking device shall be activated to enable alarm-free access at that location.
 5. The system shall configure itself as required by use of an Administrative application, and shall provide Configuration templates.
 6. The system shall monitor access control activities by use of Monitor Station, Alarm configuration, NetVue, CCTV, and dynamic Graphical Maps display of alarm, door, and event activity (Maps based on CAD data).
 7. The system shall restrict administrative and Monitoring Station activity by use of Privileges and Authentication (User Password) using Microsoft Windows OS Password Function.
 8. The system shall report on various aspects of the system by use of Reports (canned and configurable). Reports shall be able to export to a printer.
 9. The system shall have the capability to report off-normal security device conditions both audibly and visually.
 10. The system shall control hardware from the monitoring station by use of Manual actions, Events, and cause lists.
 11. The system shall provide Record and Data Management by use of Historical Journal (archive and replay), Full Audit Trail and automated and manual import and export (data and images).

12. The system shall allow for data to be imported from other products by use of database Migration tools (Card Holder data and configuration data) from, C-CURE 800/8000 and 3rd party applications via XML formatted data exchange.

2.5 EQUIPMENT

A. Server Requirements

1. The SMS Server shall meet or exceed the SMS Manufacturers requirements for the current version and series of the SMS software.

B. Client Workstation Requirements

1. The SMS client workstation shall meet or exceed the SMS Manufacturers requirements for the current version of the SMS software.

C. Badging Station Requirements

1. The SMS badging workstation shall meet or exceed the SMS Manufacturers requirements for the current version of the SMS software.

D. Controllers

1. The SMS shall support the following controller hardware:

Note: For additional information, please refer to individual A&E specifications for the controllers listed below:

- a. Software House iSTAR Classic
- b. Software House iSTAR Pro
- c. Software House iSTAR eX
- d. Software House iSTAR EDGE
- e. Software House iSTAR Ultra/Ultra SE
- f. Software House apC, apC/8X, apC/L

E. Clustering

1. The SMS shall support a user-defined grouping of iSTAR controllers defined as a cluster. iSTAR controllers within a cluster shall be able to communicate in a peer-to-peer scheme should the SMS server lose communication with the cluster.
2. Clustering shall support the following features:
 - a. Assignment of Master controllers for cluster communication to the SMS server
 - b. Primary and backup communication paths to the SMS server
 - c. Up to 16 controllers per cluster
 - d. Logical event linking between controllers in a cluster independent of SMS server communication
 - e. Antipassback control within a cluster shall be independent of SMS server communication
 - f. Asynchronous communication via TCP/IP (Polled devices shall not be acceptable)
 - g. Dialup Communications. Dialup shall only be supported on iSTAR Pro and iStar Ultra SE (in Pro Mode)
 - h. Encrypted communications
3. The SMS shall support iSTAR clusters in two types: Encrypted and Non-Encrypted. Encrypted clusters shall support iSTAR Edge/eX/Ultra controllers. Unencrypted clusters shall support iSTAR Classic/ iSTAR Pro/unencrypted Ultra controllers.

4. Network communications between a cluster master and the host, and between a cluster master and cluster members, shall be done using AES 256 bit symmetric encryption, tested and verified by an independent lab and listed for FIPS 197.
5. Encrypted iSTAR controllers shall be listed for FIPS 140-2, which meets the necessary physical, operational, and cryptographic requirements for a cryptographic module for the National Institute of Standards (NIST).

PART 3 – EXECUTION

3.1 TESTING

- A. The software shall be entered into the SMS computer systems and debugged. The Contractor shall be responsible for documenting and entering the initial database into the system. The Contractor shall provide the necessary blank forms with instructions to fill in all the required data information that will make up the database. The database shall then be reviewed by the Contractor and entered into the system. Prior to full operation, a complete demonstration of the computer real-time functions shall be performed. A printed validation log shall be provided as proof of operation for each software application package. In addition, a point utilization report shall be furnished listing each point, the associated programs utilizing that point as an input or output and the programs which that point initiates.
- B. Upon satisfactory on-line operation of the system software, the entire installation including all subsystems shall be inspected. The Contractor shall perform all tests, furnish all test equipment and consumable supplies necessary and perform any work as required to establish performance levels for the system in accordance with the specifications. Each device shall be tested as a working component of the completed system. All system controls shall be inspected for proper operation and response.
- C. Tests shall demonstrate the response time and display format of each different type of input sensor and output control device. Response time shall be measured with the system functioning at full capacity. Computer operation shall be tested with the complete data file.
- D. The Contractor shall maintain a complete log of all inspections and tests. Upon final completion of system tests, a copy of the log records shall be submitted as part of the as-built documentation.

3.2 TRAINING

- A. The Contractor shall provide a competent trainer who has extensive experience on the installed systems and in delivering training to provide the instruction. As an alternative, the Contractor may propose the use of factory training personnel and coordinate the number of personnel to be trained.

3.3 MAINTENANCE

- A. The Contractor shall offer a Software House Software Support Agreement (SSA) in order for Software House Technical Support Specialists to reactively troubleshoot system problems.
- B. As part of the agreement, 5x9 telephone support (Standard and Enhanced SSA) will be provided to the Contractor by Certified Technicians. An option of 7x24 Standby telephone support (Enhanced SSA) shall be offered.
- C. As part of the agreement, Flashable and Non-Flashable (Chips) firmware and documentation shall be provided.
- D. As part of the agreement, access to SMS patches and software release updates shall be provided.
- E. The SSA shall cover the current SMS release one full version back, and associated controller hardware.

END OF SPECIFICATIONS 28 0727

SECTION 28 07 28**CCTV – NETWORK DIGITAL VIDEO MANAGEMENT SYSTEM****PART 1 – GENERAL****1.1 SYSTEM DESCRIPTION**

- A. The Network Digital Video Management System (“Network DVMS”) shall be a feature-rich IP video distributed solution, designed for multi-site and multiple-server installations requiring 24/7 video surveillance.
- B. The Network DVMS shall consist of the following major components:
 - 1. Client Viewer.
 - 2. NVR (Network Video Recorder) Server.
 - 3. Add on: Transaction Data Integration Module.
 - 4. Add on: Central Alarm Management Module.
 - 5. Add on: PDA Server and PDA Client
- C. The Network DVMS - Client Viewer ("Client Viewer")
 - 1. The Client Viewer shall be the central operating control point for the Network DVMS system. The Client Viewer shall provide the end-user full video monitoring and control for a fully distributed solution for either single-site or multi-site applications for single-server or multiple-server installations requiring 24/7 surveillance with support for devices from different vendors.
 - 2. The Client Viewer shall uniquely integrate a multitude of disparate solutions into a single feature-rich application including seamless integration with a fully distributed, centralized-managed video surveillance platform.
 - 3. The Client Viewer shall provide an easy to use, fully integrated GUI (Graphical User Interface) that supports within the same application the following features:
 - a. Scalability - For enterprise and other high-end users, the Client Viewer shall scale to provide support for an unlimited number of cameras using multiple NVR servers. Overall, the Client Viewer shall be fully scalable to support a varying number of cameras based on the NVR server selected by the end-user, including the following other options:
 - (1) For small-to-medium (SMB) users, the Client Viewer shall scale to provide support for a maximum of 25 cameras using a single NVR server.
 - (2) For commercial users, the Client Viewer shall scale to provide support for a maximum of 64 cameras using a single NVR server.
 - b. Touch Screen Controls - The Client Viewer shall support intuitive touch-screen controls, menus and video navigation. Through the touch-screen interface the end-user shall be able to navigate menus directly from the video viewing monitor without the aid of a keyboard or mouse (no need to right click, etc.).
 - c. NVR Management - The Client Viewer shall support the management of a single Network Video Recorder (NVR), and an entire system of NVRs.
 - d. Intelligent Menus and Controls - The Client Viewer shall provide intelligent menus that automatically appear and disappear as needed by the operator to only show those controls necessary to perform the end-user function. For example, for a PTZ camera, the GUI shall intelligently show a virtual joystick to control optical zoom, digital zoom and preset controls within the camera view. The GUI shall react to the user's actions and only present those controls and tools required by the current mode of operation.

- e. Kinetic / Horizontal Timeline – The Client Viewer shall provide a user interface to allow for “kinetic” manipulation of a graphical timeline representation of recorded video. The user shall uniquely be able to kinetically (i.e., via the momentum and speed of mouse movement) vary the speed that the recorded video timescale is moved forward/backward in time.
 - f. Instant Video Playback and Analysis “Timeslicer” - The Client Viewer shall provide for instant video playback and analysis of video content/events by providing a spectrum of video thumbnails over a period of time for quick end-user analysis.
 - g. Integrated Event Management - The Client Viewer shall provide integrated event management including automation of event push video, pop-up events, and alerts without the need of additional software modules or add-on software.
 - h. Mapped Based Navigation - The Client Viewer shall provide a map-based navigation of cameras and/or camera groups.
 - i. Integration of Data for Multiple-Users – The system shall provide the ability to share and store common bookmarks and event handling data across multiple users.
 - j. Interactive Carousel - The Client Viewer shall provide fully interactive video carousel functionality, whereas a series of video camera views will presented to the end-user as a rotating carousel. For the rotating carousel, the end-user shall have the full capability to interact with the video including the ability to interrogate the video as a clip, expand the video view for the video shown, control the camera, etc.
- D. The Network DVMS – NVR
- 1. A single NVR Server or multiple NVR Servers shall provide video recording for the Network DVMS. The NVR Server shall consist of the following software components which may be resident on a single server, or installed on multiple servers within an overall Network DVMS:
 - a. Recording and Image server
 - b. Administrator Application
 - c. PDA Server.
 - 2. The Network DVMS shall support multiple NVR Servers. Each of the NVR Servers shall be assignable as either a master or a slave NVR Server.
 - 3. The NVR Server shall be used for recording video feeds and for communicating with cameras and other devices.
 - 4. The system shall support an unlimited number of NVR Servers. One or more NVR Servers may be used in a system depending on the number of cameras or physical system configuration.
 - 5. The NVR Server shall support the use of pre and post recording on motion/event recording. The pre and post recording time period shall be selectable in seconds.
 - 6. Logging – The Network DVMS shall provide an overall System log, an Event log, and an Audit log.
- E. Transaction Data Integration Module
- 1. The Network DVMS shall include support for an add-on Transaction Data Integration Module designed to integrate with Point of Sale (POS) or Automated Teller Machine (ATM) data and time-link video recordings with POS or ATM transactions.
- F. Central Alarm Management Module
- 1. The Network DVMS shall include support for an add-on graphical Central Alarm Management application module. The alarm management module shall allow for the

- continuous monitoring of the operational status and event-triggered alarms from system servers, cameras and other external devices. The alarm management module shall support graphical displays with interactive icons to display the status of cameras and other inputs.
- G. PDA (Personal Digital Assistant) Server and Client
 - 1. The Network DVMS shall include support for add-on PDA Servers and PDA Clients to allow for viewing using a remote wireless PDA.
 - H. Certified Installer Program
 - 1. The Network DVMS software vendor shall provide a certified partner program, whereby training and certification programs shall qualify the suitability of the installers. The vendor shall provide various levels of training including advanced training (i.e., “Gold” level).
 - I. Network Topology
 - 1. The Network DVMS System shall support the use of separate or common networks, VLANs or switches for connecting cameras to the NVR servers/clients. This shall provide physical network separation between the camera and servers/clients.
 - J. Virtual Computing
 - 1. The Network DVMS System shall support the use of VMware to run NVR servers and client applications on virtual computers, servers, and networks.

PART 2 – PRODUCTS

2.1 NETWORK DVMS – CLIENT VIEWER

- A. The main end-user interface and therefore the core application for the DVMS shall be the Client Viewer. The Client Viewer shall support the following features:
 - 1. A scalable solution that is frontward and backward scalable with an entire line of Network Video Recorders (NVRs).
 - 2. Intuitive, touch screen-enabled interface.
 - 3. Intelligent GUI that reacts to the user’s actions at any given moment, presenting only the controls and tools required by the current mode of operation.
 - 4. Kinetic / Horizontal Timeline – The following features shall be supported:
 - a. Kinetic variability (i.e., via the momentum and speed of mouse movement) of the speed that the recorded video timescale is moved forward/backward in time. The faster the mouse is “swiped”, the faster the timeline will move.
 - b. The timeline GUI shall provide intelligent pop-up controls for controlling forward, reverse, pause, etc. controls.
 - c. The timeline GUI shall provide simple “+” and “-“ controls to quickly change the scale of the timeline.
 - d. The timeline GUI controls shall provide an intuitive “odometer” like numerical interface for reading and changing the recorded time viewed.
 - 5. Exporting Clips – The Client Viewer shall provide multiple methods to export video clips including:
 - a. The ability to export a video segment via clicking on start and stop times (via icons) of recorded video using a timeline.
 - b. The ability to export a video segment via the use of the tool bar.
 - c. Export options shall include the ability to export to print, individual frames, and create bookmarks (on the timeline).

6. “Timeslicer” Instant Video Playback and Analysis - The Client Viewer shall provide for instant video playback and analysis of video content/events by providing a spectrum of video thumbnails over a period of time for quick end-user analysis. The user shall have the ability to vary the thumbnail intervals based on:
 - a. Time – Intervals shall be selectable.
 - b. Motion – Intervals shall be based on time or amount of motion.
 - c. Alerts.
 - d. Sequences.
7. PTZ Controls – The Client Viewer shall provide a wide variety of PTZ controls:
 - a. Both optical PTZ (if the camera is a PTZ camera) and digital PTZ controls shall be provided, including:
 - (1) Point to a location to re-center the pan-tilt field of view.
 - (2) Drag a rectangle within the current field of view to zoom into.
 - (3) Virtual joystick with intelligent pop-up menus.
 - (4) Preset overlays.
 - b. Digital PTZ controls shall be provided for both fixed cameras and PTZ cameras. Digital PTZ controls shall include instant investigation in live monitoring mode as well as for stored video. A window-in-window view shall be provided to show both the zoomed in area, as well as the full field of view of the camera.
8. Highly configurable carousel mode with controls for previous/next camera in sequence, pause/resume carousel, instant investigation capability, and optical and digital PTZ control.
9. Automated (on-event) or manual (peer-to-peer) push live video.
10. Shared and private views, configurable for up to 64 cameras from multiple servers (in multiple server installations).
 - a. Multiple hotspots.
 - b. Carousel views.
 - c. Push video views.
 - d. Web pages.
11. Multiple screen support for dual-screen and quad-screen systems.
12. Instant camera change. Quickly substitute one or more of a view's cameras with other cameras.
13. Control PTZ (Pan/Tilt/Zoom) and 360° view cameras, including a virtual PTZ joystick.
14. Use digital zoom on live as well as recorded video.
15. Manually activate surveillance system events.
16. Manually activate external outputs (e.g. sirens or lights).
17. Use sound notifications for attracting attention to detected motion or system events.
18. Get quick overviews of video sequences with detected motion.
19. Get quick overviews of detected alerts or system events.
20. Perform “Smart Searches” to quickly search selected areas of video recordings for motion.
21. Skip gaps during playback of recordings.
22. Configure and use several different joysticks.

23. Print images, with optional comments.
 24. Copy images for subsequent pasting into word processors, e-mail, etc.
 25. Export recordings (e.g. for use as evidence) in AVI (movie clip), JPEG (still image), and surveillance system database formats. The AVI and database formats can include audio.
 26. Select between language versions, independent of the language used on the main surveillance system.
- B. Log-on and Authentication
1. The Client Viewer log-on shall provide the option to select either Basic or Windows based authentication.
 - a. Basic Authentication – The Client Viewer shall support logon using an account database which requires user name and password credentials.
 - b. Windows Authentication – The Client Viewer shall support Microsoft Active Directory Support – The Client Viewer shall support logon using the NTLM (NT LAN Manager) challenge handshake with Microsoft Domain Controllers in conjunction with a local Microsoft Windows user account database.
- C. GUI Menu Options Supported
1. The Client Viewer shall provide a main GUI menu uncluttered from other menu panes. Intelligent menu items shall appear as necessary. For instance, when a camera view is right-clicked or left-click/touched and held for 1 second, various relevant selection options shall be available to the end-user:
 - a. A camera icon – to instantly select another camera; a selection of available cameras will be presented.
 - b. A clipboard icon – to save the current view to the clipboard.
 - c. A push video icon – to push video to a recipient; a selection of available recipients will be presented.
 - d. A remove camera icon – to remove the camera from the pane.
 2. In addition to the main camera view, the Client Viewer main GUI menu shall provide the end-user the following controls when “mouse” over occurs:
 - a. Select View Setup/Editing Utility
 - b. Exit
 - c. About
 3. Tool Bar - In addition to the main camera view, the Client Viewer main GUI menu shall at a minimum, provide the following tool bar selections:
 - a. View Setup/Editing Utility.
 - (1) Edit Views – Camera Views and Groups shall be organized as folders and the GUI shall provide an intuitive interface to select and change views and groups in a file folder manner. The Edit Views menu shall allow the options to add/delete shared or private views, add/delete groups, and perform other folder management functions. Camera matrix view setup options shall include: 1 x 1, 1 + 3 wide, 2 x 2, 1 + 5, 2 + 4 wide, 1 + 7, 1 + 8 wide, 3 x 3, 2 + 8, 4 x 3 wide, 4 x 4, 5 x 5, 6 x 6, 7 x 7, and 8 x 8 camera views. Edit Views shall provide utilities to configure either Shared Views or Private Views as follows:
 - (a) Shared Views – The Client Viewer shall provide both the viewing and setup for Shared Views. These Shared Views shall typically be setup by a system

administrator. The Shared Views shall be stored on the NVR and accessed by the end-user based on their log-on.

- (b) Private Views – The Client Viewer shall provide the capability for each end-user to create their own Private Views.

(2) Cameras

- (a) Server – Within the folder “Server”, the Client Server shall list the cameras by name and type of camera available within a given NVR. The Client Viewer shall allow easy manipulation of cameras and views by supporting “drag and drop” capability.
- (b) Hotspot – The Client Viewer shall support Hotspots which are typically used in the main (larger) viewing pane, surrounded by smaller panes. This feature shall allow one position of a view to be designated as a Hotspot. Specific to the Hotspot, settings for the Hotspot shall include:
 - i. Image Quality.
 - ii. Framerate.
- (c) Carousel – The Client Viewer shall support a Carousel feature for viewing of sequential multiple cameras. The setup menus for the Carrousel feature shall include:
 - i. Image Quality.
 - ii. Framerate.
 - iii. Default Dwell Time – for each camera to be viewed.
- (d) Web Page – The Client Viewer shall provide the ability to view a “Web Page” by inputting a Web URL within a text box or a JPEG image based on inputting the image file path.
- (e) Push Video – The Client Viewer shall provide the ability to display on-event live video streams and alerts. The events will be displayed in a first-in-first-out order and rotate between the different push video panes. Within the Push Video display, the setup menus for the Push Video feature shall be:
 - i. Image Quality.
 - ii. Framerate.
 - iii. TCP/IP Port.
 - iv. Password.

(3) Image Properties – The following shall be the image quality settings (may vary based on type of camera):

- (a) Quality – The Client Viewer shall provide the ability to vary picture quality. The options shall be:
 - i. Full – Native camera resolution.
 - ii. Super High.
 - iii. High.
 - iv. Medium.
 - v. Low.
- (b) Framerate – The Client Viewer shall provide the ability to vary the Framerate. The options shall be:

- i. No limit (full Framerate).
 - ii. Medium.
 - iii. Low.
- (c) Audible Alert – The Client Viewer shall produce audio alerts based on events. The options shall be:
 - i. Never.
 - ii. On Motion.
 - iii. On Event.
 - iv. On Motion or Event.
- (d) Aspect Ratio – The Client Viewer shall provide the ability to present the video as follows:
 - i. Keep Original.
 - ii. Fit to Window.

D. Client Viewer System Requirements

- 1. The Client Viewer shall allow the use of computer, servers, storage and switches from any manufacturer with components that meet the minimum requirements.
- 2. The following are the minimum requirements for the computers running the Client Viewer software:
 - a. The Client Viewer shall support Microsoft Windows XP Professional in conjunction with the Microsoft .Net 2.0 Framework, and DirectX 9.0 or newer.
 - b. CPU – Intel P4 or higher (Intel Core 2™ recommended), minimum 2.4 GHz.
 - c. RAM – Minimum of 1 GB.
 - d. Network – Ethernet (100 megabit or higher recommended).
 - e. Graphics Adapter – AGP or PCI-Express, 128 MB RAM, Direct 3D supported.

2.2 NETWORK DVMS - NVR SERVER

- A. Video Compression Format - The NVR Server shall support H.264, MPEG-4 (both ASP and SP), and MJPEG video compression formats for the video stream from all devices including analog cameras connected to encoders, DVRs, and IP cameras connected to the system.
- B. Multi-Stream Support - The NVR Server shall support multi-stream support - The NVR Server shall support H.264 / MPEG-4 / MJPEG optimized multi-streaming. The system shall allow a single video stream from a device to be independently recorded at one specified frame rate by the NVR Server, and viewed by Client Views at a different Framerate setting.
- C. Storage and Archiving - Each NVR Server shall have a default storage area. A storage area is a directory where the database content, primarily recordings from the connected cameras is stored. Recordings from the connected cameras shall be stored in individual camera databases. The system shall allow an unlimited amount of storage to be allocated for each connected device. The system shall allow archiving to be enabled on a per camera basis and allow the user to define which archiving drive shall be used for each camera.
- D. NAT Firewall Support - The system shall support port forwarding, which shall allow clients from outside of a Network Address Translation (NAT) firewall to connect to NVR Servers without using a VPN.
- E. Supported Devices
 - 1. The system shall support devices from the following manufacturers at a minimum: ACTi,

- Advantech, AgileMesh, Appro, Arecont Vision, Axis Communications, Baxall, Bosch, Canon, CBC Ganz, Convision, Digimerge, Discrete, D-Link, , DVTel, Etrovision, Extreme CCTV, FLIR Systems, GE Security, Hitron, Hunt, Infinova, Intellinet, Ipx Corporation, ipx, IQinvision / IQeye, JVC, Linudix, Lumenera, Mobotix (including support of MxPEG), Panasonic, Pelco, Pantax, Philips, Pixord, Polar, Samsung, Samsung Techwin, Sanyo, Sony, Speco, Stardot, Toshiba, Toshiba Teli, Vantage, Veo, Verint, Videology, Vivotek, Webgate, Xview.
2. The system shall support specific devices, where the specific supported model numbers shall be listed for each manufacture on an up-to-date on-line web-site.
- F. Administrator Application – The Administrator Application shall provide a feature-rich administration window for system configuration and day-to-day administration of the system. Within the Administrator Application, the following shall be selectable to allow specific system administration setup functionality. This shall include: A Service Manager, A Scheduler, General Settings, Archive Setup, the ability to Add/Edit/Remove a Device, I/O Setup and Control, and Event Setup. Sub-features shall be the ability to setup PTZs, route messages and alerts including email and SMS messaging setup, and archive setup. Specific features supported by the Administrator Application shall be:
1. Audio Settings including the ability to associate an audio feed to a video input and 2-way audio support.
 2. Motion Detection Settings including the ability to trigger video recording and events on motion.
 3. Image Quality including settings for Compression Level, Brightness, Contrast, Color, Rotate Image, and Bandwidth Control/Priority
 4. Event Notifications including how end-users will be notified when events occur.
 5. Outputs Configuration including the ability to control outputs on devices based on motion, manual control or other settings.
 6. I/O Setup including that ability to Add, Edit, Name, Enable/Disable Events and optionally assign timers to end an event sequence.
 7. Event Buttons for manually triggered events.
 8. I/O Control including a graphical mapping of all system events.
 9. User Administration including the ability to add either Basic Users or Windows (Active Directory) Users, plus the ability to Delete Users, Change Passwords, set Global User Rights, and set Camera User Rights.
- G. Outside Network Access – A user interface shall be provided to select if the system can be accessed from a client PC that has an IP address that is outside of the local IP address range. This function is used to allow access from a remote PC over the Internet. The configuration settings shall include the ability to select an Outside IP Address, Outside IP Port, Local IP Ranges, and Maximum Number of Clients
- H. NVR Server System Requirements
1. The following are the minimum requirements for the computers running the NVR Server:
 - a. CPU – Intel P4 or higher (Intel Core 2 Duo recommended), minimum 2.4 GHz.
 - b. RAM – Minimum of 1 GB (2 GB recommended).
 - c. Network – Ethernet (100 megabit or higher recommended).
 - d. Graphics Adapter – AGP or PCI-Express, minimum 1024x768 (1280x1024 recommended), 16 bit color.

- e. Hard Disk Type – E-IDE, PATA, SATA, ISCSI, SCSI, SAS (7200 RPM or faster).
- f. Hard Disk Space – Minimum 80 GB free (depends on number of cameras and recording settings).
- g. Operating System – Microsoft Vista Business/Enterprise/Ultimate (32 bit or 64 bit running as a 32 bit application), Windows 2003 Server (32 bit or 64 bit running as a 32 bit application), and Windows XP Professional (32 bit or 64 bit running as a 32 bit application).

2.3 TRANSACTION DATA INTEGRATION MODULE

- A. The Transaction Data integration module shall allow the operator to search and view Transaction Data from third-party systems time-linked with video recordings of when the transaction activities occurred.
- B. The module shall integrate digital video surveillance images with Point of Sale (POS) or Automated Teller Machine (ATM) transaction data. The module shall allow the operator to efficiently answer questions critical to an investigation.
- C. The module shall allow the ATM or POS transaction data to be integrated with the system via an open interface supporting a serial server, serial cable or IP connection. The module shall be compatible with any TCP/IP or serial ASCII data source.
- D. The module shall include a filter to allow the user to edit the transaction data and remove unwanted or unnecessary data from the ATM or POS database.
- E. The module shall allow the user to search for transactions by register/ATM, camera, date, time or free text. All Transaction Data shall be stored in a SQL database.
- F. The module shall utilize a client / server architecture using HTTP or TCP directly for communication.

2.4 CENTRAL ALARM MANAGEMENT MODULE

- A. The alarm management module shall allow for continuous monitoring of the operational status and event-triggered alarms from servers, cameras and other devices. The alarm management module shall provide a real-time overview of alarm status or technical problems while allowing for immediate visual verification and troubleshooting.
- B. The alarm management module shall provide an interface and navigational tools through the client. The module shall provide a detailed listing of all active or incoming alarms with the ability to reassign alarms to other operators.
- C. The module architecture shall be .NET based with the server component accessed through a client application running on Windows XP Professional or Windows Server 2003 servers. Central logging of incoming alarms and system information in a SQL database.

2.5 PDA CLIENT

- A. The PDA Client shall allow for the viewing of live and recorded images within the Network DVMS using a wireless PDA.
- B. The PDA Client shall provide a camera menu to select a camera to view, PTZ controls including presets, recorded video playback controls, and event management.

2.6 PDA SERVER

- A. PDA Server shall be provided as an optional front-end add-on module to the NVR Server.
- B. The PDA Server shall provide an interface between NVR Server and the remote PDA clients
- C. The PDA Server shall use the Microsoft IIS (Internet Information Services) and .Net framework.

END OF SECTION

SECTION 32 12 43 POROUS FLEXIBLE PAVING

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

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. Porous Flexible Paving at Courtyard Tree Pits.
- B. Related Requirements:
 - 1. Section 312000 – "Earth Moving" for subgrade preparation and subbase courses.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at the site.

1.5 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Urethane binder.
 - 2. Aggregate mixture.
- B. Sieve Analyses: For aggregate materials, according to ASTM C 136.
- C. Samples:
 - 1. Physical sample of the product for approval.

1.6 QUALITY ASSURANCE

- A. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Construct 48" X 48" mockup for approval.

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2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless the Professional specifically approves such deviations in writing.

1.7 INSTALLER QUALIFICATIONS

- A. Flexible Porous Paving installer shall be required to be familiar with installation procedures and to have attended the Manufacturer installation training program.
- B. Flexible Porous Paving installer shall employ no less than two Manufacturer-trained Flexible Porous Paving technicians on staff who directly oversee and perform the installations during all Flexible Porous Paving placement.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Protect stored rubber and aggregate from moisture by covering material with sheet plastic. Binder to be stored within a temperature range of 45 to 90 degrees F.
- B. Avoid placing pervious paving if rain, snow, or frost is forecast within 24 hours. Protect fresh paving from moisture and freezing.
- C. Base aggregate shall be a clean washed 3/4" stone.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Products: Subject to compliance with requirements, provide the following:
 1. Flexible Porous Paving:
 - a. Basis of Design:
 - 1) Manufacturer: PorousPave Incorporated, Grant, MI, Phone Number (888) 448-3873
 - a) Colors to be selected from manufacturer's full range of colors.
 - b) 100% Rubber Mix: PorousPave XLR.
 - c) Binding agent: Moisture-cured urethane liquid.
 - d) Mix Design: Using materials mix ratio as acceptable by the Manufacturer for the intended application.
 - e) Forms shall be clean and free of debris of any kind, rust, and hardened concrete and make use of vegetable oil as a form release.
 - b. Approved manufacturers:
 - 1) Rubberway- North East Branch, Greenwich, CT, 203-869-1741
 - 2) Urban Rubber Paving- Calgary, 403-689-7748.
- B. Edge Restraints:
 1. See construction drawings.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Prepare subgrade as specified in the contract documents or as directed by the Engineer. Porous Flexible Paving has a thickness of 2", over Clean Coarse Aggregate (#57 stone) with 95% compaction per AASHTO T-180, with an ideal thickness of 4 inches over stabilized sub-base.
- B. Construct sub-grade to ensure that the required paving thickness is obtained in all locations.
- C. Keep all traffic off subgrade during construction to the maximum extent practical.
- D. Coat and recoat mixer and wheelbarrow as needed with vegetable oil, it will make clean up easier and also allows for the best finish on the installation.
- E. Apply form release agent to the temporary form face which will be in contact with pervious paving, immediately before placing paving.
- F. Protect previously placed paving from damage.
- G. Apply liquid urethane bonding agent to face of surfaces when adhesion is desired.

3.2 INSTALLATION, GENERAL

- A. MIXING: Mix on site in compliance with Manufacturer's written specifications.
- B. Placing and Finishing Paving
 - 1. Do not place Flexible Porous Paving on frozen or wet subgrade or subbase.
 - 2. Deposit Flexible Porous Paving either directly onto the subgrade or subbase by wheelbarrow or by material handler onto the subgrade or subbase, unless otherwise specified.
 - 3. Deposit Flexible Porous Paving between the forms to an approximately uniform height.
 - 4. Mix one ounce of original green Palmolive per one gallon of water in a bucket. Using a rag soaked in the soapy water, apply or wipe the soapy water mix over trowels and bull floats.
 - 5. Spread the pervious paving uniformly to the required elevation and screed to achieve a uniform flat surface.
- C. Final Surface Texture
 - 1. Final surface of pervious paving shall be smoothed with bull float and magnesium hand floats coated with a form release film.
- D. Edging
 - 1. Aluminum edging material.
- E. Curing
 - 1. Once 2-3 mixes have been installed, using a garden sprayer filled with water, apply a mist of water over the entire surface of the material. This will decrease the curing time of the Porous Pave. Misting must be done on all installations to ensure best results.

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2. The binder is moisture cured. Allow at least a 6-hour window for rain. If any rain or excess moisture becomes a factor before the installation cures, the binder will foam up and cannot be repaired.
- F. Hot and Cold Weather Construction
1. Can be installed from 45° to 95°F temperatures.
 2. It is important that the temperature doesn't fall below 45° F for about six hours after the installation. The binder cannot freeze until fully cured.

END OF SECTION

**SECTION 32 13 13
CONCRETE PAVING****PART 1 - GENERAL****1.1 SUMMARY**

- A. The Work of this Section includes all labor, materials, equipment, services and transportation required to furnish, deliver, and install cast-in-place concrete work shown on the Drawings, as specified herein, or both, including but not limited to items noted below:
1. Concrete work includes, but is not limited to, installing all:
 - a. Exposed Aggregate Concrete Paving on site and within Courtyard areas.
 2. Furnishing fabricating, and placement of reinforcing steel, dowels, welded wire fabric, fillers, and related accessories for concrete work.
 3. Construction and removal of all related and required formwork and centering, shoring, bracing, anchorage and related accessories. Designing and detailing of forms and shores by Contractor's Engineer.
 4. Furnishing and installing joint fillers, bonding compounds, joint sealants and other miscellaneous items specified or shown.
 5. Installing embedded items in concrete furnished as part of other work of Project such as anchor bolts, anchors, supports, sleeves, hangers, frames, and the like.

1.2 RELATED SECTIONS

- A. Section 312000 EARTH MOVING
- B. Section 321216 ASPHALT PAVING
- C. Section 321373 – CONCRETE PAVING JOINT SEALANTS

1.3 SUBMITTALS

- A. General: Make submittals in accordance with Section 01 33 00 Submittal Procedures.
- B. Product Data: Submit manufacturer's complete technical data sheets for the following:
1. All concrete materials and concrete admixtures used for project.
- C. Design Mixes: For each type of concrete.
- D. Qualification Data: For firms indicated in section 01 40 00 Quality Requirements, include a list of completed projects.

1.4 QUALITY ASSURANCE

- A. Codes and Standards: Comply with provisions of following codes, specifications and standards, except where more stringent requirements are shown or specified:
 - 1. Concrete Reinforcing Steel Institute (CRSI), "Manual of Standard Practice".
 - 2. ACI 301, Structural Concrete for Buildings.
 - 3. ACI 303.1, Standard Specification for Cast-In-Place Architectural Concrete.
 - 4. ACI 304, Recommended Practice for Measuring, Mixing, Transporting and Placing of Concrete
 - 5. ACI 305R, Hot Weather Concreting.
 - 6. ACI 306R, Cold Weather Concreting.
 - 7. ACI 316R, Recommendations for Construction for Concrete Pavements and Bases.
 - 8. ASTM C309, Standard Specification for Chemical Admixtures for Concrete.
 - 9. ASTM C979, Standard Specification for Pigments for Integrally Colored Concrete.
 - 10. AASHTO Md194, Chemical Admixtures.
- B. Materials and installed work may require testing and retesting at anytime during progress of work. Tests, including testing of rejected materials and installed work, shall be done at Contractor's expense.
- C. Mockups: Cast exposed aggregate concrete sidewalk in a 5' x 8' panel to demonstrate finish texture, tint, joints, tolerances, and standard workmanship.
 - 1. The mockup should be approved by the Landscape Architect prior to commencing final sitework for the concrete sidewalks.
- D. Obtain materials from same source and maintain high degree of consistency in workmanship throughout Project.
- E. Manufacturer Qualifications: Manufacturer shall have ten-years experience in the production of specified products.
- F. Installer Qualifications: Concrete shall be finished by firm with five-years experience with work of similar scope and quality.

1.5 PROJECT CONDITIONS

- A. Avoid placing concrete if rain, snow or frost is forecast within 24-hours. Protect fresh concrete from moisture and freezing.
- B. Schedule placement to minimize exposure to wind and hot sun before curing materials are applied.
- C. Comply with professional practices described in ACI 305R and ACI 306R.
- D. Schedule delivery of concrete to provide consistent mix times from batching until discharge. Mix times shall meet manufacturer's written recommendations.

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- E. Protect adjacent finish materials against spatter during concrete placement.

PART 2 - MATERIALS

2.1 FORM MATERIALS

- A. Forms for Exposed Finish Concrete: Metal forms to provide continuous, straight, smooth, exposed surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on drawings.
- B. Forms for Unexposed Finish Concrete: Plywood, lumber, metal or other acceptable material. Provide lumber dressed on at least 2 edges and one side for tight fit.
- C. Form Coatings: Provide commercial formulating form-coating compounds that will not bond with, stain nor adversely affect concrete surfaces, and will not impair subsequent treatments of concrete surfaces.
- D. Form Ties: Factory-fabricated, adjustable-length, removable or snapoff metal form ties, designed to prevent form deflection and to prevent spalling concrete upon removal. Provide units, which will leave no metal closer than 1-1/2" to surface.
 - 1. Provide ties which, when removed, will leave holes not larger than 1" diameter in concrete surface.

2.2 REINFORCING MATERIALS

- A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.
- B. Steel Wire: ASTM A 82, plain, cold-drawn, steel.
- C. Welded Wire Fabric: ASTM A 185, welded steel wire fabric. Mesh reinforcing shall electric welded fabric with an ultimate yield point of at least 72,000 psi.
- D. Supports for Reinforcement: Bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcing bars and welded wire fabric in place. Use wire bar type supports complying with CRSI specifications, unless otherwise acceptable.
- E. Joint Dowel Bars: Plain steel bars, ASTM A 615, Grade 60. Cut bars true to length with ends square and free of burrs.

2.3 CONCRETE MATERIALS

- A. Portland Cement: ASTM C 150, Type 1.
- B. Use one brand of cement through project, unless otherwise acceptable to Landscape Architect.
- C. Fine Aggregate/Concrete: sand for concrete work shall conform to ASTM Specification C-33, and shall be composed of clean, hard, durable, uncoated grains free from silt, loam and clay, uniformly graded to meet the following grading requirements:
 - 95% passing #4 sieve;
 - 35-75% passing #16 sieve;
 - not more than 10% passing #100 sieve;
 - not more than 3% lost by washing.
- D. Coarse Aggregate/Concrete: shall be crushed stone conforming to ASTM Specification C-33 and shall be composed of clean, hard, durable uncoated grains of strong material, uniformly graded to meet the following requirements:
 - 100% passing 1 ½" screen;
 - 90-100% passing 1" screen;
 - 35-65% passing ½" screen; and 0.8% passing #4 sieve.
- E. Normal Weight Aggregates: ASTM C 33, and as herein specified. Provide aggregates from a single source for exposed concrete.
 - 1. For exterior exposed surfaces, do not use fine or coarse aggregates containing spalling-causing deleterious substances.
 - 2. Local aggregates not complying with ASTM C 33 but which have shown by special test or actual service to produce concrete of adequate strength and durability may be used when acceptable to the Architect.
- F. Decorative Exposed Aggregate Stone: shall be ¼' River Grit stone as supplied by Wicki Wholesale Stone, Inc., Great Meadows, NJ, Phone: 908-637-6004, or approved equal. Color to be in the Gray range.
- G. Water: Potable.
- H. Air-Entraining Admixture:
 - 1. ASTM C 260, certified by manufacturer to be compatible with other required admixtures.
 - 2. Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to, the following:
 - "Air-Mix"; Euclid Chemical Co.
 - "Sika Aer"; Sika Corp.
 - "MB-VR or MB-AE"; Master Builders.
 - "Dorex AEA"; W. R. Grace.
 - "Edoco 2001 or 2002"; Edoco Technical Products.

“Air-Tite”; Gifford-Hill/American Admixtures.

I. Water-Reducing Admixture:

1. ASTM C 494, Type A, and contain not more than 0.1 percent chloride ions.
2. Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to, the following:
“WRDA Hycol”; W. R. Grace.
“PSI N”; Gifford-Hill/American Admixtures.
“Eucon WR-75”; Euclid Chemical Co.
“Pozzolith 344”; Master Builders.
“Plastocrete 160”; Sika Chemical Corp.
“Chemtard”; Chem-Masters Corp.
“Pro-Kete-N”; Protex Industries, Inc.

J. Water Reducing, Non-Chloride Accelerator Admixture:

1. ASTM C 494, Type E, and containing not more than 0.1 percent chloride ions.
2. Available Products: Subject to compliance with requirements, products; which may be incorporated in the work include, but are not limited to, the following:
“Acccelguard 80”; Euclid Chemical Co.
“Pozzolith 500”; Master Builders.
“Gilco Accelerator”; Gifford-Hill/American Admixtures.

K. Water Reducing, Retarding Admixture:

1. ASTM C 494, Type D, and contain not more than 0.1 percent chloride ions.
2. Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to, the following:
“Edoco 20006”; Edoco Technical Products.
“Pozzolith 300-R”; Master Builders.
“Eucon Retarder 75”; Euclid Chemical Co.
“Daratard”; W. R. Grace.
“PSI R”; Gifford-Hill/American Admixtures.
“Plastiment”; Sika Chemical Co.
“Protard”; Protex Industries, Inc.

- L. Prohibited Admixtures: Calcium chloride thycyanates or admixtures containing more than 0.1 percent chloride ions are not permitted.

2.4 RELATED MATERIALS:

A. Non-Shrink Grout:

1. CRD-C 588, factory pre-mixed grout.
2. Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to, the following:
Non-metallic:
“Set Grout”; Master Builders.

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“SonogROUT”; Sonneborn-Rexnord.
 “Euco-NS”; Euclid Chemical Co.
 “Supreme”; Gifford-Hill/American Admixtures.
 “Crystex”; L & M Cons. Chemical Co.
 “Sure-Grip Grout”; Dayton Superior Corp.
 “Horngrout”; A. C. Horn.
 “Five Star Grout”; U. S. Grout Corp.

B. Bonding Compound:

1. Polyvinyl acetate or acrylic base.
2. Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to, the following:
Acrylic or Styrene Butadiene:
 “J-40 Bonding Agent”; Dayton Superior Corp.
 “Everbond”; L & M Construction Chemicals.
 “Hornweld”; A. C. Horn.
 “Sonocrete”; Master builders solutions.
 “Acrylic Bondcrete”; The Burke Co.
 “SBR Latex”; Euclid Chemical Co.
 “Daraweld C”; W.R. Grace.

C. Expansion Joint Material: expansion joint filler shall be pre-molded material (non-asphaltic) of an approved manufacturer and of a thickness as shown on the Drawings and filled with an approved two-part polysulfide or polyurethane base expansion joint sealer. Color to match concrete or as specified on drawings.

D. Expansion Joint Cap: Snap Cap plastic joints sealers by W.R. meadows.

E. Stabilization Fabric: Mirafi 500X (or equal).

2.5 PROPORTIONING AND DESIGN OF MIXES

A. Prepare design mixes for each type and strength of concrete.

B. Submit written reports to Owner’s Representative of each proposed mix for each class of concrete at least 15 days prior to start of work.

C. Provide design mixes to obtain minimum compressive strengths indicated:

1. Plaza Paving: 4000psi, 28-day compressive strength.
2. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant; at no additional cost to Owner and as accepted by Engineer. Laboratory test data for revised mix design and strength results must be submitted to and accepted by Owner’s Representative before using in work.

D. Admixtures:

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1. Use water-reducing admixture or high range water-reducing admixture (super plasticizer) in concrete as required for placement and workability.
 2. Use non-chloride accelerating admixture in concrete slabs placed at ambient temperatures below 50 degrees F (10 degrees C)
 3. Use air-entraining admixture in all exterior exposed concrete. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having total air content with a tolerance of plus-or-minus 1-1/2 percent within following limits:
 - a. Concrete exposed to freezing and thawing, De-icer chemicals, or subjected to hydraulic pressure:
 - b. 5.0 percent (moderate exposure); 6.0 percent (severe exposure) $\frac{3}{4}$ " max. aggregate.
 4. Use admixtures for water-reducing and set-control in strict compliance with manufacturer's directions.
- E. Water-Cement Ratio: Provide concrete with maximum water-cement (W/C) ratios of W/C 0.46.
- F. Slump Limits: Proportion and design mixes to result in concrete slump at point of placement as follows:
1. Curbs, ramps, walks, and sloping surfaces: Not more than 3".
 2. Concrete containing HRWR admixture (super-plasticizer): Shall not have slump more than 8" after addition of HRWR to verified 2"-3" slump concrete.
 3. Other Concrete: Not more than 4".
 4. For concrete to be vibrated: Slump as determined by ASTM C143. Tolerances as established by ASTM C94.

2.6 CONCRETE MIXES

- A. Job-Site Mixing: Mix materials for concrete in appropriate drum type batch machine mixer. For mixers of one cu. yd., or smaller capacity, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released. For mixers of capacity larger than one cu. yd., increase minimum 1-1/2 minutes of mixing time by 15 seconds for each additional cu. yd., or fraction thereof.
- B. Provide batch ticket for each batch discharged and used in work, indicating project identification name and number, date, mix type, mix time, quantity, and amount of water introduced.
- C. Ready-Mix Concrete: Comply with requirements of ASTM C 94, and as herein specified.
- D. During hot weather, or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified in ASTM C 94 may be required.
1. When air temperature is between 85 degrees F (30 degrees C) and 90 degrees F (32 degrees C) reduce mixing and delivery time from 1-1/2 hours to 75 minutes, and when air temperature is above 90 degrees F (32 degrees C), reduce mixing and delivery time to 60 minutes.

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- E. Admixtures: Add admixtures to concrete mix according to manufacturer's written instructions.

PART 3 - EXECUTION

3.1 GENERAL

- A. Coordinate the installation of joint materials with placement of forms and reinforcing steel.

3.2 PREPARATION OF SUBGRADE

- A. The finished subgrade shall be parallel to the finished surface and shall be crowned or pitched to an even gradient parallel to finished surface. Do all necessary excavation.
- B. All soft and yielding material, and other portions of the subgrade which will not compact readily when rolled or tamped, shall be removed or broken off to a depth of not less than one (1') foot below the finished surface of the subgrade. All holes and depressions shall be filled with suitable material and the whole surface compacted uniformly by rolling the entire area with an approved power roller weighing not less than 10 tones. Any portion, which is not accessible to a roller, shall be thoroughly compacted by hand tamping. Any creepage of the grade while being rolled shall indicate insufficient compaction.
- C. Precautions shall be taken as necessary to protect the subgrade from damage. Construct and maintain the crown or pitch, in such a condition that it will drain readily and correctly.
- D. The subgrade shall in every area be compacted to 95 percent of the maximum density, except that in areas of fill, the top layer shall be compacted to 98 percent of maximum density. Subgrade shall be firm and unyielding before application of the stone base course.

3.3 GRANULAR SUBBASE

- A. The coarse aggregate shall be spread uniformly over the subgrade to a depth such as when compacted, the thickness shall be 6". Dumping of the aggregate in piles on the subgrade will not be permitted. Rolling shall be started immediately after the spreading of the aggregate with a self-propelled three-wheel roller weighing not less than 10 tons. Rolling shall continue until the coarse aggregate is firmly locked and keyed together, the appearance and surface texture is uniform and all ridges are removed. The rolled surface shall not vary more than 3/8" when measured with a 10 foot straight edge. Any variation from the above shall be corrected by loosening and reshaping and re-rolling. In places inaccessible to the roller, the aggregate shall be compacted by hand tampers.
- B. Prior to installing granular subbase, place stabilization fabric across entire surface of compacted subgrade. Install and secure over-lapping fabric panels per manufacturer's recommendations / instructions.
- C. Smoothness Test and Thickness Control: Test the completed subbase for grade and cross section with a straight edge. The surface of each layer shall not show any deviations in excess of 3/8-inch. The completed thickness shall be within 1/2-inch of the thickness as shown.

- D. Protection: Maintain the finished subbase in a smooth and compacted condition until the concrete has been placed. When Contractor's subsequent operations or adverse weather disturbs the approved compacted subbase, excavate, and reconstruct it with new material meeting the requirements herein specified, at no additional cost to the Owner.

3.4 FORMS

- A. Design, erect, support, brace and maintain formwork to support vertical and lateral, static, and dynamic loads that might be applied until such loads can be supported by concrete structure. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation and position. Maintain formwork construction tolerances complying with ACI 301.
- B. Design formwork to be readily removable without impact, shock or damage to cast-in-place concrete surfaces and adjacent materials.
- C. Construct forms to sizes, shapes, lines, and dimensions shown, and to obtain accurate alignment, location, grades, level and plumb work in finished structures. Provide for openings, drainage holes, anchorages, and inserts, and other features required in work. Use selected materials to obtain required finishes. Solidly butt joints and provide backup at joints to prevent leakage of cement paste.
- D. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, recesses, and the like, to prevent swelling and for easy removal.
- E. Provisions for Other Trades: Provide openings in the concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses and chases from trades providing such items. Accurately place and securely support items built into forms.
- F. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt or other debris just before concrete is placed. Re-tightening forms and bracing after concrete placement is required to eliminate mortar leaks and maintain proper alignment.

3.5 PLACING REINFORCEMENT

- A. Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars", for details and methods of reinforcement placement and supports, and as herein specified.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials, which reduce or destroy bond with concrete.
- C. Accurately position, support and secure reinforcement against displacement by formwork, construction, or concrete placement operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as required.

- D. Place reinforcement to obtain at least minimum coverage for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.

3.6 CONCRETE PLACEMENT

- A. Pre-placement Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast-in. Notify other crafts to permit installation of their work; cooperate with other trades in setting such work. Moisten wood forms immediately before placing concrete where form coatings are not used.
- B. General: Comply with ACI 304R “Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete”, and as herein specified.
- C. Fog spray forms, reinforcing steel and subgrade just before concrete is placed.
- D. Deposit concrete, continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as herein specified. Deposit concrete as nearly as practicable to its final location to avoid segregation.
- E. Placing Concrete in Forms: Deposit concrete in forms in horizontal layers not deeper than 24” and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.
- F. Consolidate placed concrete by hand-spading, rodding and tamping.
- G. Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.
- H. Bring slab surfaces to correct level with straightedge and strike-off. Use bull floats or darbies to smooth surface, free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations.
- I. Exposed Aggregate Pavement:
 - 1. Prior to starting installation, Landscape Architect is to approve color blend aggregate.
 - 2. The seeding operation shall start immediately after placement of concrete as described above.
 - 3. The select aggregate shall be carefully and uniformly seeded by hand so that the entire surface is completely covered with one layer of stone. Stacked stone as well as slivery particles shall be removed at this time. The aggregate shall be embedded by tamping with a wood float.
 - 4. Under no circumstances shall areas lacking in mortar be filled with small quantities of the base concrete mix.
 - 5. In preparation for exposed aggregate finish, the strikeoff and bullfloat operations shall be such that a level surface is obtained sufficiently below the final finish grade to allow for volume growth due to addition of seeding aggregate.

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- J. Maintain reinforcing in proper position during concrete placement operations.
- K. Cold Weather Placing: Protect concrete work from physical damage or reduced strength, which could be caused by frost, freezing actions, or low temperatures, in compliance with ACI 306 and as herein specified.
- L. When air temperature has fallen to, or is expected to fall below 40 degrees F (4 degrees C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 degrees F (10 degrees C), and not more than 80 degrees F (27 degrees C) at point of placement.
- M. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
- N. Do not use calcium chloride, salt and other materials containing antifreeze agents or chemical accelerators, unless otherwise accepted in mix designs.
- O. Hot Weather Placing: When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.
- P. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90 degrees F (32 degrees C). Mixing water may be chilled, or chopped ice may be used to control the temperature provided water equivalent of ice is calculated to total amount of mixing water. Use of liquid nitrogen to cool concrete is Contractor's option.
- Q. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before imbedding in concrete.
- R. Use water-reducing retarding admixture (type D) when required by high temperatures, low humidity, or other adverse placing conditions.
- S. Install a construction joint whenever the placing of concrete is suspended for more than 30 minutes and at the end of each day's work.

3.7 CONCRETE FINISHES – GENERAL

- A. The sequence of operations, unless otherwise indicated, shall be as follows:
 - 1. Consolidating, floating, straight-edging, troweling, texturing, and edging of joints.
 - 2. Maintain finishing equipment and tools in a clean and approved condition.

3.8 CONCRETE FINISHING OF PEDESTRIAN PAVEMENT

- A. Finish the surfaces to grade and cross section with a metal float, trowled smooth and finished with a broom moistened with clear water.
- B. Brooming shall be transverse to the line of traffic.

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- C. Finish all slab edges, including those at formed joints, carefully with an edger having a radius as shown on the drawings.
- D. Except where indicated on drawings, edge the transverse joints before brooming. The brooming shall eliminate the flat surface left by the surface of the edger. Execute the brooming so that the corrugation, thus produced, will be uniform in appearance and not more than 1/16-inch in depth.
- E. The completed surface shall be uniform in color and free of surface blemishes and form marks. The finished surface of the pavement shall not vary more than 3/16-inch when tested with a 10-foot straightedge.
- F. The thickness of the pavement shall not vary more than 1/4-inch.
- G. Remove and reconstruct irregularities exceeding the above for the full length between regularly scheduled joints.
- H. The finished surface of the pavement shall not vary more than 1/4-inch.

3.9 FINISHING OF EXPOSED AGGRGATE PAVEMENT

- A. When the concrete is hard enough to retain the embedded aggregate and the mortar is still soft enough to be removed by brushing, the surface shall be brushed and flushed with water. The final washing operation shall cease when the flush water runs clear and there is no noticeable cement film on the aggregate.
- B. Work shall be planned so that the concrete placing and aggregate seeding procedures are coordinated with the capabilities with the capabilities of the washing and brushing crew.
- C. When a surface retarder is used, it must be approved by the Architect. The retarder shall be applied uniformly over the concrete surface in accordance with the manufacturer's instructions.
- D. Care must be taken to ensure that run-off waters are treated in accordance with local by-laws and regulations. It is the responsibility of the Concreter and Architect's representative to confer on this matter prior to commencement of the entire operation.

3.10 JOINTS

- A. Provide cork, "Cementone" or equal NON-ASPHALTIC joint filler for expansion joints abutting concrete curbs, catch basins, manholes, inlets, structures, walks and other fixed objects, unless otherwise indicated.
- B. Locate expansion joints in walkways and plaza areas as per the locations noted on the construction drawings.
- C. Extend joint fillers full-width and depth of joint, and not less than 1/2" or more than 1" below finished surface where joint sealer is indicated. If no joint sealer is specified, place top of joint filler flush with finished concrete surface.

- D. Furnish joint fillers in one-piece lengths for full width being placed. Where more than one length is required, due to excessive distances, lace or clip joint filler sections together.
- E. Protect top edge of joint filler during concrete placement with a metal cap or other temporary material. Remove protection after concrete has been placed on both sides of joint.
- F. Joint Sealer: Comply with manufacturer's printed instructions except where more stringent requirements are shown or specified, and except where manufacturer's technical representative directs otherwise.
 - 1. Clean joint surfaces immediately before installation of gaskets, sealants or caulking compounds. Remove dirt, insecure coatings, moisture and other substrates, which could interfere with seal of gasket or bond of sealant or caulking compound. Etch concrete and masonry joint surfaces as recommended by sealant manufacturer.
 - 2. Prime or seal joint surfaces where indicated, and where recommended by sealant manufacturer. Confine primer/sealer to areas of sealant bond; do not allow spillage or migration onto adjoining surfaces.
 - 3. Cure sealants and caulking compounds in compliance with manufacturer's instructions and recommendations, to obtain high early bond strength, internal cohesive strength and surface durability. Cure and protect sealants in a manner, which will minimize increases in modulus of elasticity and other accelerated aging effects. Replace or restore sealants, which are damaged or deteriorated during construction period.
- G. Score Joints: Score contraction joints in sidewalks are to be as indicated on the drawings or as specified. Sawn cut or tooled joints as shown.

3.11 PREPARATION OF FORM SURFACES

- A. Clean re-used forms of concrete matrix residue, repair and patch as required to return forms to acceptable surface condition.
- B. Coat contact surfaces of forms with a form-coating compound before reinforcement is placed.
- C. Thin form-coating compounds only with thinning agent of type, amount, and under conditions of form-coating compound manufacturer's directions. Do not allow excess form-coating material to accumulate in forms or to come into contact with in-place concrete surfaces against which fresh concrete will be placed. Apply in compliance with manufacturer's instructions.
- D. Coat steel forms with a non-staining, rust-preventative form oil or otherwise protect against rusting. Rust-stained steel formwork is not acceptable.

3.12 CONCRETE CURING AND PROTECTION

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- B. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Weather permitting; keep continuously moist for not less than 7 days.

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- C. Begin final curing procedures immediately following initial curing and before concrete has dried. Continue final curing for at least 7 days in accordance with ACI 301 procedures. Avoid rapid drying at end of final curing period.
- D. Curing Methods: Perform curing of concrete by moist curing.
- E. Precautions shall be taken in hot weather to prevent plastic cracking resulting from excessively rapid drying at surface as described in CIP 5 'Plastic Shrinkage Cracking' published by the National Ready Mixed Concrete Association.
- F. Do not cover concrete with plastic sheeting.

3.13 REMOVAL OF FORMS

- A. Formwork not supporting weight of concrete, such as the sides of walls, columns, and similar parts of the work, may be removed after cumulatively curing at not less than 50 degrees F (10 degrees C) for 24 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form removal operations, and provided curing and protection operations are maintained.

3.14 RE-USE OF FORMS

- A. Clean and repair surfaces of forms to be re-used in work. Split, frayed, delaminated or otherwise damaged form facing material will not be acceptable for exposed surfaces. Apply new form coating compound as specified for new formwork.
- B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close joints. Align and secure joint to avoid offsets. Do not use "patched" forms for exposed concrete surfaces.

3.15 CONCRETE SURFACE REPAIRS

- A. Patching Defective Areas: Repair and patch defective areas with cement mortar immediately after removal of forms, when acceptable to Owner's Representative.
- B. Cut out honeycomb, rock pockets, voids over ¼" in any dimension, and holes left by tie rods and bolts, down to solid concrete but in no case to a depth of less than 1". Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water and brush-coat the area to be patched with specified bonding agent. Place patching mortar after bonding compound has dried.
- C. Repair concealed formed surfaces, where possible, that contain defects that affect the durability of concrete. If defects cannot be repaired, remove and replace concrete.
- D. Repair of Unformed Surfaces: Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface plane to tolerances specified for each surface and finish. Correct low and high areas as herein specified. Test unformed surfaces sloped to drain for trueness of slope, in addition to smoothness, using a template having required slope.

- E. Repair finished unformed surfaces that contain defects which affect durability of concrete. Surface defects, as such, include crazing, cracks in excess of 0.01" wide or which penetrate to reinforcement or completely thorough non-reinforced sections regardless of width, spalling, pop-outs, honeycomb, rock pockets, and other objectionable conditions.
- F. Correct low areas in unformed surfaces during, or immediately after completion of surface finishing operations by cutting out low areas and replacing with fresh concrete. Finish repaired areas to blend into adjacent concrete. Proprietary patching compounds may be used when acceptable to Landscape Architect.
- G. Repair defective areas, except random cracks and single holes not exceeding 1" diameter, by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean, square cuts and expose reinforcing steel with at least 3/4" clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding compound. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact and finish to blend with adjacent finished concrete. Cure in the same manner as adjacent concrete.
- H. Repair isolated random cracks and single holes not over 1" in diameter by dry-pack method. Groove top of cracks and cut-out holes to sound concrete and clean of dust, dirt and loose particles. Dampen cleaned concrete surfaces and apply bonding compound. Mix dry-pack, consisting of one part Portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing. Place dry-pack after bonding compound has dried. Compact dry-pack mixture in place and finish to match adjacent concrete. Keep patched area continuously moist for not less than 72 hours.
- I. Repair methods not specified above may be used, subject to acceptance of Architect.

3.16 QUALITY CONTROL TESTING DURING CONSTRUCTION

- A. The Construction Manager will employ a testing laboratory to perform tests and to submit test reports.
- B. Sampling and testing for quality control during placement of concrete may include the following, as directed by Owner's Representative.
- C. Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94.
 - 1. Slump: ASTM C 143; one test at point of discharge for each day's pour of each type of concrete; additional tests when concrete consistency seems to have changed.
 - 2. Air Content: ASTM C 173, volumetric method for normal weight concrete; ASTM C 231 pressure method for normal weight concrete; one for each day's pour of each type of air entrained concrete.
 - 3. Concrete Temperature: Test hourly when air temperature is 40 degrees F (4 degrees C) and below, and when 80 degrees C (27 degrees C) and above; and each time a set of compression test specimens made

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4. Compression Test Specimen: ASTM C 31; one set of 3 standard cylinders for each compressive strength test, unless otherwise directed. Mold and store cylinders for laboratory cured test specimens except when field-cure test specimens are required.
5. Compressive Strength Tests: ASTM C 39; one set for each day's pour exceeding 5 cu. yds. plus additional sets for each 50 cu. yds. over and above the first 25 cu. yds. of each concrete class placed in any one day; one specimen tested at 7 days, two specimens tested at 28 days, and one specimen retained in reserve for later testing if required.
 - a. When frequency of testing will provide less than 5 strength tests for a given class of concrete, conduct testing from at least 5 randomly selected batches or from each batch if fewer than 5 are used.
 - b. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.
 - c. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength, and no individual strength test result falls below specified compressive by more than 500 psi.
- D. Test results will be reported in writing to Landscape Architect and Contractor on same day that tests are made. Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials; compressive breaking strength and type of break for both 7-day tests and 28-day tests.
- E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted but shall not be used as the sole basis for acceptance or rejection.
- F. Additional Tests: The testing service will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by Architect. Testing service may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed. Contractor shall pay for such tests when unacceptable concrete is verified.

PART 4 - CLEAN UP

4.1 GENERAL

- A. Upon the completion of the installation, all debris created by the installation shall be removed from the premises of the Owner or disposed of as directed.

END OF SECTION

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SECTION 32 13 73 CONCRETE PAVING JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Work of this Section includes all labor, materials, equipment and services necessary to furnish, deliver, and install Work of the Section as shown on Drawings, as specified or as required by job conditions.
 - 1. The installation of each form and type of joint sealer as indicated on the Drawings and identified by provisions of this Section.
 - 2. General Performance: Except as otherwise indicated, joint sealers are required to establish and maintain airtight and waterproof continuous seals on a permanent basis, within recognized limitations of wear and aging as indicated for each application. They shall provide a quality bond. Failures of installed sealers to comply with this requirement will be recognized as failures of materials and workmanship.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 321313 – CONCRETE PAVING

1.3 SUBMITTALS

- A. General: Make submittals in accordance with Section 01 33 00 Submittal Procedures.
- B. Submittals shall include actual sealant samples with color as selected by Owner's Representative.

1.4 JOB CONDITIONS

- A. Weather Conditions: Do not proceed with installation of liquid sealants under unfavorable weather conditions. Install elastomeric sealants when temperature is in lower third of temperature range recommended by manufacturer for installation.
- B. Where sealant is specified for joints, bituminous expansion joint filler is NOT to be used below sealant. Use closed cell polyethylene for expansion joint filler below sealant which requires no bond breaker.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General Sealer Requirements: Color as selected by Landscape Architect to match pavement. Select materials for compatibility with joint surfaces and other indicated exposures, and except as otherwise indicated, select modulus of elasticity and hardness or grade recommended by manufacturer for each application indicated. Where exposed to foot traffic, select non-tracking

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materials of sufficient strength and hardness to withstand stiletto heel traffic without damage or deterioration of sealer system.

B. Elastomeric Sealants

1. Approved Products (or approved equal):
 - “Masterseal NP II” by Master Builders Solutions
 - “MasterSeal® NP 150™ Sealant Paving Joint Sealant” by Master Builders Solutions
 - Miscellaneous Materials
2. Joint Primer/Sealer: Provide type of joint primer/sealer recommended by sealant manufacturer for joint surfaces to be primed or sealed.
3. Bond Breaker Tape: Do not use. Expansion joint and sealant materials shall be compatible so as not to require bond-breaker tape. Contact manufacturer for more information.

PART 3 - EXECUTION

3.1 General

- A. Apply sealant where shown on drawing details.
- B. Apply sealant where structure abuts another similar or different structure.

3.2 Inspection

- A. Contractor shall examine substrates, joint surfaces and conditions under which joint sealer work is to be performed. Do not proceed with joint sealer work until unsatisfactory conditions have been corrected.

3.3 Joint Preparation

- A. Clean joint surfaces immediately before installation of gaskets, sealants or caulking compounds. Remove dirt, insecure coatings, moisture and other substrates, which could interfere with seal of gasket or bond of sealant or caulking compound. Etch concrete and masonry joint surfaces as recommended by sealant manufacturer. Roughen vitreous and glazed joint surfaces as recommended by sealant manufacturer.
- B. Prime or seal joint surfaces where indicated, and where recommended by sealant manufacturer. Confine primer/sealer to areas of sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.4 Installation

- A. Comply with manufacturer's printed instructions except where more stringent requirements are shown or specified, and except where manufacturer's technical representative directs otherwise.

3.5 Cure and Protection

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- A. Cure sealants and caulking compounds in compliance with manufacturer's instructions and recommendations, to obtain high early bond strength, internal cohesive strength and surface durability. Cure and protect sealants in a manner that will minimize increases in modulus of elasticity and other accelerated aging effects. Replace or restore sealants that are damaged or deteriorated during construction period.

END OF SECTION

SECTION 32 17 23
DECORATIVE INTERCONNECTED PAVEMENT MARKING

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 RELATED SECTIONS

- 1. Section 321216 - "Asphalt Paving" for new asphalt pavement.

1.3 SUMMARY

- A. Decorative interconnected pavement marking shall consist of a durable aggregate reinforced preformed thermoplastic pavement marking system (herein "System") that provides a textured, aesthetically attractive and durable topical treatment to the surface of the asphalt or concrete pavement.
- B. The System is intended for use on asphalt or concrete pavements to create interesting and colorful surface designs. It is applied over pavement to create decorative and colorful site gathering spaces as shown on the Contract Drawings.
- C. All System materials shall be produced under a quality system as specified in this section and designed to provide durability, load carrying capacity and architectural compatibility with the location. All raw materials shall be graded for consistency and quality to obtain the required standards.
- D. The System shall be installed to the newly installed substrate.
- E. Only accredited or qualified decorative interconnected system installers authorized by the applicable manufacturer of the decorative interconnected product may perform this work.
 - 1. Work to be installed by a TrafficScapes Certified Applicator.

1.4 UNIT PRICES

- A. Work under this Section is based on labor and materials per project.
- B. Method of Measurement: The work will be measured by the installed area of square feet, measured and accepted in place. No deduction will be made for the area(s) occupied by manholes, inlets, drainage structures, bollards or by any public utility appurtenances within the area.
- C. Basis of Payment: This work will be paid for at the Contract unit price per square foot for "Decorative Interconnected Pavement Marking" and accepted in place. Price shall include all materials, equipment, tools and labor incidental thereto. There will be no separate payment for

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surface preparation; but the cost of this work shall be considered as included in the general cost of the work.

1.5 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at the Summit Campus site in Middletown, DE.
- B. Conference shall consist of Owner, Owners Representative, Engineer, Landscape Architect, and Accredited or Qualified Installer, manufacturer's representative.

1.6 DEFINITIONS

- A. "HMA pavement" is Hot Mix Asphalt pavement.
- B. "PCC pavement" is Portland Cement Concrete pavement.
- C. "Owner" means the Owner and refers to the representative person of the Owner who has decision making authority for the Work. The "owner" typically references the city, county, or government entity agreeing to the project's purchase.
- D. "Accredited or Qualified Installer" refers to a contractor authorized by the System manufacturer to install the decorative interconnected pavement marking (system).

1.7 SUBMITTALS

- A. Product Data: For each type of product per manufacturer's offering.
- B. Manufacturer Data: System type and product type
- C. Samples for Initial Selection: For each type of product requiring color selection.
Samples for Verification: For each pattern and color in manufacturer's standard sizes.
- D. The Accredited or Qualified Installer shall provide written proof of their accreditation.
- E. The Accredited or Qualified Installer shall gain confirmation of correct decorative interconnected pattern(s) and colors from the Landscape Architect prior to starting the Work.
- F. The Accredited or Qualified Installer shall supply three references of work of a similar nature provided to the Owners Representative, within the State of Delaware.
- G. The System manufacturer must be ISO9001:2015 certified for design, development and manufacturing of preformed thermoplastic, and provide proof of current certification.
- H. Shop Drawings:
Indicate decorative interconnected pavement marking patterns, colors, and dimensions to adjacent work

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1.8 QUALITY ASSURANCE

- A. Installer Qualifications: Accredited or Qualified Installer required for this Project.
- B. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of ASTM D4505, and the State of Delaware for decorative interconnected pavement marking work.

1.9 FIELD CONDITIONS

- A. Environmental Limitations: Proceed with decorative interconnected pavement marking only when air temperature is at least 45 deg F (7.2 deg C) and rising. Proceed only if no precipitation is expected. Ensure there is no moisture in the substrate prior to application. Surface should not have any frost or moisture present. High winds could also affect the installation of the material.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Manufacturer -

Basis of Design – Ennis-Flint, Inc. TrafficScapes® - DecoMark® interconnected surface system
1. Contact www.ennisflint.com

- B. DECORATIVE INTERCONNECTED PAVEMENT MARKING MATERIAL

1. Preformed Thermoplastic Material: Must be composed of an ester modified rosin, impervious to degradation by motor fuels and lubricants, in conjunction with aggregates, pigments, binders, and anti-skid/anti-slip elements. Pigments and anti-skid/anti-slip elements must be uniformly distributed throughout the material. The material conforms to AASHTO designation M249, except for relevant differences due to the material being supplied in a preformed state, being non-reflective, and being of the colors specified on the construction drawings.
2. The System shall utilize an aggregate reinforced preformed thermoplastic product which contains a minimum of thirty percent (30%) intermixed anti-skid/anti-slip elements and where the top surface contains anti- skid/anti-slip elements. These anti-skid/anti-slip elements must have a minimum hardness of 9 (Mohs scale).
3. The System must be resistant to the detrimental effects of motor fuels, antifreeze, lubricants, and hydraulic fluids.
4. Pigments:
 - a. White: The material shall be manufactured with sufficient titanium dioxide pigment to meet FHWA Docket No. FHWA-99-6190 Table 5 and Table 6 as revised and corrected.

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- b. Other Colors: The pigment system must not contain heavy metals nor any carcinogen, as defined in 29 CFR 1910.1200, in amounts exceeding permissible limits as specified in relevant Federal Regulations.
 5. Skid Resistance: The surface of the material shall contain factory applied anti-skid/anti-slip elements with a minimum hardness of 9 (Mohs scale). Upon application the material shall provide a minimum skid resistance value of 60 BPN when tested according to ASTM E 303.
 6. Thickness: The material must be supplied at a minimum thickness of 125 mil (3.2mm).
 7. Environmental Resistance: The material must be resistant to deterioration due to exposure to sunlight, water, salt or adverse weather conditions and impervious to oil and gasoline.
- C. HEATING EQUIPMENT: Infrared heating equipment is designed specifically to elevate the temperature of the preformed thermoplastic material and asphalt or concrete pavement without adversely affecting it and System manufacturer-approved infrared heating equipment must be used for application. For small areas requiring additional heat, a manufacturer approved torch may be used.
- D. MATERIALS SEALER: A two-part epoxy sealer specified and distributed by the System manufacturer must be applied to the substrate prior to material application to ensure proper adhesion, and to provide reinforcement for larger areas of material.
- E. MATERIALS AGGREGATE: Supplemental anti-skid/anti-slip elements to be applied to the surface of the molten preformed thermoplastic as needed, if the factory applied anti-skid/anti-slip elements embed too deeply into the surface of the molten preformed thermoplastic material during the heating process. (Embedded aggregate is exposed upon wear for extended skid resistance.) The aggregate is distributed by the System manufacturer.
- F. PATTERNS & COLORS
 1. Patterns and colors are described below:
 - a. Decorative interconnected markings: Courtyard Walkways and Plaza Areas.
Patterns: As shown on the construction drawings.
Color 'A': Light Blue
Color 'B': Sky Blue
Color 'C': Light Grey
 2. Contractor shall verify all colors and patterns with owner's representative and landscape architect prior to placement.
- G. SHELF LIFE AND STORAGE The shelf life of decorative interconnected pavement marking materials is two years provided it is protected from the weather, specifically UV degradation and rain. The materials are to be stored in their original packaging and kept dry under cover and or as per manufacturer's specifications.

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PART 3- EXECUTION

3.1 EXAMINATION

- A. Verify that pavement is dry and in suitable condition to begin the installation process according to manufacturer's written instructions.
- B. Proceed with asphalt or concrete installation only after unsatisfactory conditions have been corrected.

3.2 DECORATIVE INTERCONNECTED PAVEMENT MARKING SUBSTRATE

- A. General: Decorative interconnected pavement marking may be applied to both asphalt and concrete according to manufacturer's written instructions, using manufacturer's recommended equipment.
- B. PRE-CONDITIONS: Decorative interconnected pavement marking shall be installed over asphalt or concrete substrates that are firm, stable and in excellent condition; it must be free from defects such as cracks, settlement, visible seams, ruts, bird baths and spalling.
 1. Cracking, settlement and other deficiencies of the substrate will likely reflect through the decorative preformed thermoplastic. Good and proper construction procedures for the installation of the substrate must be followed in order to mitigate cracking of decorative preformed thermoplastic.
 2. Surfaces with a high degree of porosity should be avoided due to the problems associated with entrapped water.
 3. Surfaces that may be subject to uncontrolled movement in either a horizontal or vertical direction shall be avoided as there may be a risk of reflective cracking through to the decorative preformed thermoplastic. Notify the engineer if these conditions are present before installing decorative preformed thermoplastic.
- C. PREPARING OF THE SUBSTRATE: All pavement substrates must be of high quality and stable for the installation of decorative interconnected pavement marking.

This Section is to be used as a guide to ensure a high-quality pavement substrate is provided and ready for the installation of the decorative System. It does not supersede other specifications pertaining to this Work, nor does it replace recommendations made by the engineer of record for this Work.

1. The base and sub-grade over which new pavement is installed must be firm and stable.
 2. The pavement mix must be designed for the intended use.
 3. The pavement must be installed in accordance with proper placement practices and these specifications.
 4. The asphalt or concrete pavement must cure properly before installing decorative interconnected pavement marking.
- D. SURFACE PREPARATION: The pavement surface shall be dry and clean: free of all dirt, debris, salts, concrete admixtures and any chemical residues.

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1. Bituminous residue must be removed from new asphalt pavement surface prior to installation of decorative interconnected pavement marking.
2. Removal of contaminants may be done by brooming, compressed air, pressure washing (moisture must be removed and the surface dry as noted above) or, if necessary, light-grit blasting. Wire brush may be used to remove loose or powdery materials.

E. **INSTALLATION OF DECORATIVE INTERCONNECTED PAVEMENT MARKING:**
Decorative interconnected pavement marking System is to be installed only by an Accredited or Qualified Installer.

1. The System must be able to be applied to asphalt or concrete surfaces without pre-heating the application surface to a specific temperature.
2. The System is applied to asphalt or concrete pavement primarily using an infrared heating equipment. An approved hand-held propane heat torch distributed by the System manufacturer shall be used to heat isolated areas of the preformed thermoplastic.
3. A specialized sealer dispensing gun, handheld finishing tool and aggregate is used as part of the installation process
4. The aggregate reinforced preformed thermoplastic is typically supplied in panels measuring 2 ft. x 3 ft. [$\pm \frac{1}{8}$ in.] (.61m x .91m [± 3 mm]).
5. The System is available in a variety of standard colors and patterns. See construction drawings for detailed pattern and color information.
6. The material must be able to be applied at ambient and road temperatures with a minimum temperature of 45°F (7°C) and rising.
7. A two-part epoxy sealer specified by the manufacturer must be applied to the substrate prior to preformed thermoplastic application. Immediately following sealer application, the panels of aggregate reinforced preformed thermoplastic are positioned properly on the asphalt or concrete substrate with the aggregate side facing up. The preformed thermoplastic is then heated to the required melting temperature by use of a System manufacturer approved infrared heater. An approved hand-held propane heat torch distributed by the System manufacturer shall be used to heat isolated areas of the preformed thermoplastic. Additional aggregate may be applied to the preformed thermoplastic surface as needed following the melting process.
8. The preformed thermoplastic material is then allowed to cool thoroughly before being opened to vehicle or pedestrian traffic. (Consult the manufacturer's published application procedures for complete information.) The timing of opening traffic will be subject to exterior temperature conditions. More time may be required in hot weather. The Accredited or Qualified Installer can advise when the work is ready for traffic.

F. **PACKAGING:**

1. The DecoMark[®] preformed thermoplastic material shall be packaged in cardboard cartons with a plastic sheet between each layer of preformed thermoplastic. The cartons in which the DecoMark marking system is packed shall be non-returnable and shall not exceed 40 in. (1.02m) in length and 25 in. (.64m) in width. The cartons shall be labeled for ease of identification. The weight of the individual carton must not exceed seventy (70) pounds (32 kg). A protective film around the carton must be applied to protect the DecoMark preformed thermoplastic material from rain or premature aging.

G. **TECHNICAL SERVICES:**

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1. The successful bidder shall provide technical services as required.

END OF SECTION

SECTION 32 18 13 SYNTHETIC TURF

PART 1 – GENERAL

1.01 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.02 SECTION INCLUDES

- B. Multi-purpose infilled porous synthetic turf courtyard surfacing.

1.03 RELATED SECTIONS

- A. Section 312000 – “Earth Moving”
- B. Section 334100 – ” Storm Utility Drainage Piping”
- C. Section 334600 – “Subdrainage”

1.04 REFERENCES

- A. Comply with applicable requirements of the following standards. Where these standards conflict with other specified requirements, the most restrictive requirements shall govern. The latest edition of the following standards as referenced herein shall be applicable.
- B. Factory Mutual Research Corporation: FM P7825 Approval Guide
- C. American Society for Testing and Materials Standards
 - 1. ASTM D418 – “Standard Method of Testing Pile Yarn Floor Covering Construction”
 - 2. ASTM D422 – “Standard Test Method for Particle Size Analysis of Soils”
 - 3. ASTM D698 – “Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cubic foot)”
 - 4. ASTM D1335 – “Standard Test Method for Tuft Bind of Pile Yarn Coverings”
 - 5. ASTM D1557 – “Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cubic foot)”
 - 6. ASTM D1577 – “Standard Test Method for Linear Density of Textile Fibers”
 - 7. ASTM D1682 – “Standard Method of Tests for Breaking Load and Elongation of textile Fabrics”
 - 8. ASTM D2256 – “Standard Test Method for Tensile Properties of Yarns by the Single Strand Method”
 - 9. ASTM D2859 – “Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials”
 - 10. ASTM D2922 – “Standard Test Methods for Density of Soil and Soil Aggregate in Place by Nuclear Methods”
 - 11. ASTM D3385 – “Standard Test Method for Infiltration Rate of Soils in Field Using Double Ring Infiltrometer”

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12. ASTM D5034 – “Standard Test Method for Breaking Strength and Elongation of Textile fabrics (Grab Test)”
13. ASTM D5848 – “Standard Test Method for Mass per Unit Area of Pile Yarn Floor Coverings”
14. ASTM F355 – “Standard Test Method for Shock Absorbing Properties of Playing Surface Systems and Materials”
15. ASTM F1015 – “Standard Test Method for Relative Abrasiveness of Synthetic Turf Playing Surfaces”
16. ASTM F1551 – “Standard Test Method for Comprehensive Characterization of Synthetic Turf Playing Surfaces and Materials”
17. PSAL – “Standards set forth by Public School Athletic League Governing Sport Authority”

1.05 SYSTEM DESCRIPTION

A. Design Requirements

1. Labor, materials, tools and equipment necessary to install multipurpose, artificial turf courtyard surfacing as indicated on the contract documents in strict accordance with the manufacturer’s installation instructions and all approved shop drawings.

1.06 SUBMITTALS

A. Comply with the requirements of Section 01330 – Submittal Procedures and as modified below.

B. Product Data

1. Submit manufacturer’s product literature, technical specifications, product characteristics, performance characteristics, installation instructions and similar information demonstrating compliance with the specified requirements.
2. Submit fiber manufacturer’s name, type of fiber and composition of fiber.
3. Provide sample copy of all required warranties as specified in this section.
4. Provide certification of sub-base acceptance.
5. Adhesive: Product literature shall be submitted prior to installation.
6. Maintenance Manuals: Prior to final acceptance, submit 3 copies of Maintenance Manuals, which shall include all necessary instructions for the proper care and preventative maintenance of the synthetic turf system, including any painting or markings.

C. Shop Drawings: Shop drawings shall be prepared at the scale of the construction documents, or larger, and shall contain all pertinent information regarding installation, including seaming plan and edge detail. These drawings shall be submitted to Sikora Wells Appel for approval prior to the manufacturing and shipping. Provide submissions of the following shop drawings indicating:

1. Synthetic Turf area layout.
2. Roll and seaming layout.
3. Methods of attachment, field openings and perimeter conditions. Include all details for conditions where synthetic turf will be applied to covers, plugs, etc.

D. Samples: Provide submissions of the following samples:

1. Synthetic Turf: Two samples, minimum 12” X 12” for the type indicated on the drawings.

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2. Fall Attenuation Pad Sample: Two samples, minimum 12" x 12" in size of shock pad for approval.
3. Seam Tape Sample: Contractor shall submit a 12" is size sample of the seaming tape the manufacturer is proposing to use.
4. Recycled Plastic Lumber Edge: One sample, minimum 3" x 6" for approval.
5. Infill material: 6 oz. container.

E. Quality Control Submittals

1. Test Reports
 - a. Submit certified copies of independent, third-party laboratory test reports for synthetic turf playfield system components as follows:
 - (1) Pile height, face width and total fabric weight per ASTM D418 or D5848.
 - (2) Primary and secondary backing weights per ASTM D418 or D5848.
 - (3) Tuft bind per ASTM D1335.
 - (4) Grab tear strength per ASTM D1682 or D5034.
 - (5) Pill burn test per ASTM D2859.
 - b. Submit necessary test data from the Installer to the Department indicating that the finished field meets the required shock attenuation as per ASTM F355.
2. Existing Installation Listing: Provide a list, including project name, owner's representative name and telephone number for a minimum of five (5) fields/ areas of 5,000 SF or more installed in the United States during the past two years with the same manufacturer, product and company, including the exact same system, fiber and fiber manufacturer proposed for this project. The synthetic turf manufacturer must certify the designated supervisory personnel on the project as competent. The Contractor shall submit for approval, the name and qualifications of the proposed sub/Contractor. The Contractor shall submit the following:
 - a. A letter on turf manufacturer's letterhead affirming the Sub/Contractor as competent in the installation of the material, including seams and proper installation of their product.
 - b. Proof of five (5) installations of the proposed material by the proposed Sub/Contractor.
 - c. Name, address, and phone numbers for a minimum of three (3) professional references associated with synthetic turf work performed by proposed Sub/Contractor.
3. Drainage Stone Base Acceptance: Prior to beginning of installation of new synthetic turf over the installed drainage stone base, arrange for a representative of the synthetic turf manufacturer and installer to inspect the drainage base stone. The manufacturer and the installer must certify the acceptance of the drainage base stone for the purpose of obtaining the manufacturer's warranty for the finished synthetic playing surface.
 - a. Certificate of Sub-Base Acceptance: Acceptance of permeable drainage stone base shall be submitted on turf manufacture's letterhead.

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4. Lead Components – As part of the approval process of the submitted product, the synthetic turf playfield system supplier must certify in writing that no lead or lead chromate components are utilized in the manufacturing of the turf.

- F. Closeout Procedures: Comply with the requirements of Section 01732. The submission shall include maintenance instructions as specified in the “Operating and Maintenance Data” manual requirements described in this section including all necessary instructions for the proper care and preventative maintenance of the new synthetic turf system including and actual locations of seams, drains or other pertinent information.

1.07 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in the manufacturing of products specified in this section.
 1. The turf manufacturer must have ten (10) installations of 50,000 square feet or more of the specific type turf system and specified and has been in use for a minimum of three years.
- B. Installer Qualifications: Company specializing in the installation of synthetic turf and systems specified for this project and complying with the following requirements:
 1. Provide trained technicians skilled in the installation of playground quality synthetic turf systems working under the direct supervision of approved supervisors to provide cutting, sewing, gluing, shearing, top dressing or brushing operations.
 2. Installer must have successfully installed at least ten (10) outdoor installations of synthetic turf within interior building courtyards, and playing field systems similar to that required for this project and who is acceptable to the manufacturer. Provide letter from manufacturer approving the installer.
 3. Designated supervisory personnel on the project certified by the synthetic turf manufacturer as competent in installation of the proposed material, including sewing seams and the proper installation of the mixture and shock pad.
 4. Provide representatives on the site to certify installation and warranty compliance.
 5. Provide letter from Manufacturer approving the installer.
- C. Pre-Installation Meeting: Schedule and conduct a pre-installation meeting at least one week prior to the beginning of the installation of the synthetic grass surfacing system including the Department, Sikora Wells Appel, Contractor or designated representative, applicable subcontractor representatives and synthetic grass surfacing representative.
- D. Installed Systems Shall Comply With the Following:
 1. Flammability: Passes flame spread and smoke development as tested in accordance with ASTM D2859.
 2. Permeability: Surfaces shall drain up to 10 inches of rain per hour over a 24-hour period.
 3. Relative Abrasiveness: Abrasive index of 20.2, as measured in accordance with ASTM F1015.

1.08 PROJECT CONDITIONS

- A. Existing Conditions: Repair damage to any porous stone base prior to installation of the synthetic grass surfacing system.
- B. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit synthetic turf work to be performed according to manufacturers' written instructions and warranty requirements. Do not deliver or install surfacing material if either ambient air temperature or material temperature is below 32 degrees F.
- C. Field/ Area Measurements: Establish and maintain required lines and elevations for grade control. Verify measurements shown on the Contract Documents in field prior to ordering or installing materials.
- D. Existing Utilities: Do not disturb or interrupt existing utilities unless permitted in writing by Sikora Wells Appel and then only after arranging to provide temporary utility services, if required.
- E. Product Handling:
 - a. Turf system material shall be protected before, during and after installation.
 - b. Installed work and materials of other trades shall also be protected.
 - c. Do not expose geo-textile fabric to sunlight for more than one week during its storage and installation.

1.09 SEQUENCING AND SCHEDULING

- A. Proceed with and complete synthetic turf construction as rapidly as portions of the site become available, working within seasonal limitations for the work required.
- B. Coordinate synthetic turf installation to ensure perimeter edge details, underground storm piping and connections and other associated work required for the system as detailed and recommended by the manufacturer and approved by Sikora Wells Appel are provided.

1.10 WARRANTY

- A. The Prime Contractor and/or Manufacturer shall provide a warranty to the Department that includes the following in writing in the warranty document:
 - 1. The turf warranty shall be from a single source and shall provide full coverage for all defects in all materials and workmanship of the synthetic turf for its intended usability and playability for a period of eight (8) years from the date of Final Completion and acceptance of the turf field. The turf manufacturer must verify that their on-site representative has inspected the installation and that the work conforms to the manufacturer's requirements.
 - 2. The turf warranty shall include general wear and damage caused from ultra-violet degradation.
 - 3. The turf warranty shall specifically list what components and properties are covered by the warranty. The list shall include but not limited to any and all defects or failures relating to construction of the synthetic turf system and stone base, drainage through the synthetic turf system and drainage base stone, synthetic turf seam rupture, synthetic turf yarn ultra-violet

stability, excessive wear stipulated as more than a 40% decrease in pile height and tensile strength.

4. The turf warranty shall cover defects in the workmanship of installation and further warrants that the installation was done in accordance with both the manufacturer's recommendations and any written directives of the manufacturer's on-site representative.
5. The turf warranty shall include all necessary materials, labor, transportation costs, etc., to complete repairs or replacements. The warranty shall guarantee the availability of the same or better replacement materials for the synthetic turf system for the warranty period.
6. The turf warranty shall be non-prorated and shall not place limits on the amount of field's usage.
7. The turf warranty shall clearly define the conditions under which the manufacturer considers the warranty to be void.
8. The turf warranty shall define the typical time frame within which repairs will be initiated by the synthetic turf contractor, once notice has been received requesting repairs.
9. The warranty shall be for the full value, not prorated.

1.11 MAINTENANCE

- A. Maintenance Service: Beginning at Substantial Completion and continuing through Warranty Period, the Manufacturer shall provide yearly maintenance service. The service shall be performed by skilled employees of an Installer certified by the Manufacturer. This maintenance service shall include the following:
 - a. Check seams and interface points for continuity. Repair as required.
- B. Three (3) copies of the Maintenance Manual shall describe for the Department the materials, devices and procedures to be followed for use and maintenance of the synthetic turf system, including cleaning.
- C. The synthetic turf contractor shall provide training for the Department regarding the recommended maintenance program for the synthetic turf. The training shall include a detailed review of the turf maintenance manual required to be provided by the synthetic turf manufacturer.
- D. Extra Materials: Upon final completion, provide the following materials directly to the Department in the minimum quantities specified:
 1. Seaming Tape – 100 LF
 2. Seaming Epoxy – One standard sized pail.
 3. Turf fabric (Green) – 150 SF with at least one piece 15' wide by 10' long.
 4. Manufacturer's recommended stiff brush

PART 2 PRODUCTS

2.01 MATERIALS

- A. Basis of Design:
 - i. SYNRYe 239 by SYNLawn.
 - ii. 100% Nylon Fiber (no blends permitted).
 - iii. Max Pile Height: 1 1/2"

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- 1.) Approved manufacturers:
 - a. Turf Tek USA- Commack, NY, Phone: 631-651-5777.
 - b. Pro Green Synthetic Turf Systems- Long Island, NY, Phone: 516-758-2897.

- B. Synthetic Turf Infill Material: EnviroFill green coated infill for turf 16/30 sieve size.
 - i. Themotzgroup.com/ Envirofill
- C. Accessories: Glue, thread, paint, seaming fabric, infill and other materials used to install the synthetic grass surfacing system shall be provided as recommended by the synthetic turf manufacturer.

- D. Clean Washed Stone (for Synthetic Grass Surfacing Drainage Base): Thicknesses as indicated on drawings:
 - a. 3/4" clean stone: AASHTO #57

 - b. 3/8" clean stone: AASHTO #8

 - c. Screenings: AASHTO #10

- E. Perimeter Edging: See drawings. Composition and mechanical properties of synthetic wood (recycled plastic lumber) perimeter board shall be as follows:
 - a. Minimum High-Density Polyethylene: 70%
 - b. Tensile Strength (ASTM D638): 1200 psi
 - c. Compressive Strength (ASTM D6108): 1200 psi
 - d. Flexural Modulus of Elasticity (ASTM D6109): 100,000 psi
 - e. Average Nail Pull Out Strength (ASTM D6117): 280 lbs.
 - f. Size: 1" x 3" x 12'

- F. The Bulk Density and Specific Gravity of the recycled plastic lumber shall conform to the acceptable standards determined by the standard test method in ASTM D6111. Recycled plastic lumber shall not absorb moisture, corrode, rot, warp, splinter, or crack and the surface shall not be slippery when wet. The recycled plastic lumber shall not contain any material that will be irritating when in contact with skin. Cross sections shall not show wide deep gaps or holes and the surface shall have a wood-like grain texture and appearance. Plastic lumber shall remain unpainted.

- G. Shock Pad (Fall Attenuation Pad): ABZORB by REGUPOL
 - a. Thickness: 12 mm.
 - b. Regupol.us

- H. Underdrain System:
 - a. See construction drawings

- I. Geotextile Drainage Fabric: Mirafi 140N
 - a. 4 oz.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Installer Verification of Conditions: Examine conditions under which the synthetic turf area is to be constructed with the materials and components specified in this section. The Department and Sikora Wells Appel shall be notified in writing of any conditions detrimental to the proper and timely installation of the work.
1. Arrange for synthetic turf installer to inspect the stone drainage base and accept in writing this sub-base surface for planarity and compaction. Arrange for installer to have dimensions of the field and locations for markings measured by a registered land surveyor to verify conformity to the specifications and applicable standards and make record of finished field as-built measurements.
 2. Arrange for the synthetic grass surfacing manufacturer to inspect and certify that the stone drainage base area to receive the synthetic grass surfacing is ready for installation of the system, is perfectly clean as the installation commences, and will be maintained in that condition throughout the installation process.
 3. When the installer confirms conditions as being acceptable to ensure proper and timely installation of the work and to ensure requirements of applicable warranties or guarantees can be satisfied, submit written confirmation to Sikora Wells Appel. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to the installer.

3.02 INSTALLATION

- A. Install synthetic turf system in accordance with the manufacturer's instructions: obtain written acceptance of any variance from the manufacturer's on-site representative (submit copy to Sikora Wells Appel), verifying that changes do not in any way affect warranty.
1. Preparation of the artificial turf subgrade and stone drainage base shall be performed in accordance with Section 312000 – Earth Moving.
 2. Installation of the shock pad, shall be in accordance with manufacturer's recommendations.
 3. Installation of stormwater drainage system shall be in accordance with construction drawings and technical written specifications.
- B. After the stone drainage layer grades have been approved and confirmed to match construction drawing elevations, details, and specifications, the resilient shock pad shall be installed under entire area of synthetic turf.
1. Equipment and personnel shall take extreme care to minimize disturbance of the stone base during shock pad installation.
 2. All operations shall work from behind the rolled-out shock pad or from adjacent, pre-installed pad surface.
 3. One head seam shall be allowed per length. Head seams shall be staggered so as not to be within 10' of the previously installed roll.
 4. The head seam shall overlap approximately 4 inches on original roll out. Second and subsequent rolls shall be rolled out within 1 inch, or less, of the previous roll and allowed to expand or contract before manually sliding in place.

5. After allowance for expansion or contraction, the padding shall slide into place so as to touch the edge or seam of the previous. Care shall be taken so as not to disturb the choker layer material when butting the seams together.
- C. The Resilient shock pad shall not receive a final cut or edging detail until the material has relaxed/expanded in direct sunlight for a minimum of six hours.
 1. No open seams shall exceed 1/4" (in expanded state) after final seam or end cutting is complete.
 2. Padding material shall stop just short of the exposed nailer board.
- D. The Resilient Shock Pad shall be inspected by the Contractor after completion to ensure the surface is smooth with only minor bumps from stone particles or other material protruding from underneath that will not show up once the turf is laid over top.
 1. Expansion bubbles and open seams shall be repaired prior to final inspection.
 2. Repeat inspections shall be carried out prior to each roll of synthetic turf being installed.
 3. Install synthetic playfield carpet rolls directly over the properly placed stone base taking extreme care to avoid damaging or moving the base material.
 4. Lay full width rolls across the field of sufficient length to permit full cross field installation from sideline to sideline without head or cross seams in the main playing area between sidelines. Use standard state of the art sewing procedures to attach each roll to the next roll. When all rolls of the playing surface have been attached, install sideline areas at right angles to the playing field synthetic turf area.
 5. Provide 99% sewn installation; gluing of rolls shall not be acceptable. Minimal gluing will be permitted to repair problem areas, corner completions. All seams shall be sewn using double bagger stitches and polyester thread per the manufacturer's standard procedures. Make all seams flat, tight and permanent without separation or fraying. Stitches shall be every one-half (1/2") or less. All seams shall be transverse to the field direction (perpendicular). Seams shall be flat, tight, and permanent with no separation or fraying.
 6. Adhesive: Gluing shall be a solvent based, one-part, high green strength urethane. Adhesive installations shall be glued down with minimum 12" wide textured seam tape. Adhesive shall be spread not in excess of 30 linear feet of seam tape per gallon of adhesive. Hot melt glue and two-part epoxy systems are not acceptable.
 7. Apply materials in numerous thin lifts and brush the turf as the mixture is applied. Install to the depth determined by the manufacturer. Install materials to fill voids between the fibers and to allow the fibers to remain vertical and non-directional. Install mix at the lbs/sq. yd rate as described in paragraph 2.01 D.
 8. Attach the synthetic grass surfacing to the perimeter edge as detailed in the Contract Documents and in strict accordance with the synthetic turf manufacturer's standard recommendations.

3.03 FIELD MARKINGS

There are no logos, markings, layouts, or field lines proposed for this project.

3.04 FIELD QUALITY CONTROL

- A. Material Testing: No testing is required for this application in its intended use as a passive sitting area.

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3.05 ADJUSTING AND CLEANING

- A. Provide final cleaning of synthetic grass surfacing installations and maintain the area clean and free from debris during installation. Clean surfaces, recesses, enclosures and similar areas as required, leaving the area of installation in a clean, immaculate condition ready for immediate occupancy and use by the Department.
- B. All usable remnants of new material shall become the property of the school district.
- C. Protect the installed synthetic grass surfacing from subsequent construction operations. Do not permit traffic over unprotected surfacing.

3.06 ACCEPTANCE

- A. Before the acceptance of work, should any imperfect areas or spots develop in the surface, such areas shall be removed and replaced with new materials. All such repair work shall be done at no additional cost to the school district.

END OF SECTION

SECTION 32 18 16.13 PLAYGROUND PROTECTIVE SURFACING

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. References
 - 1. Public Playground Safety Handbook (U.S. Consumer Product Safety Commission)
 - 2. ASTM F2479-12 Standard Guide for Specification, Purchase, Installation and Maintenance of Poured-In-Place Playground Surfacing
 - 3. ASTM F1292 Standard Specification for Impact Attenuation of Surfacing Materials within the Use Zone of Playground Equipment
 - 4. ASTM F1487-11 Standard Consumer Safety Performance Specification for Playground Equipment for Public Use
 - 5. ASTM F1951-09B Standard Specification for Determination of Accessibility of Surface Systems Under and Around Playground Equipment

1.2 SUMMARY

- A. Section Includes:
 - 1. Unitary synthetic poured rubber seamless surface.
 - 2. Organic loose-fill surface.
 - 3. Inorganic loose-fill surface.
- B. Related Sections:
 - 1. Division 32 Section 321216 "Asphalt Paving"
 - 2. Division 03 Section 033005 "Cast-In-Place Concrete for Landscaping"

1.3 DEFINITIONS

- A. Critical Height: Standard measure of shock attenuation. According to CPSC No. 325, this means "the fall height below which a life-threatening head injury would not be expected to occur."
- B. SBR: Styrene-butadiene rubber.
- C. Fall Height: According to ASTM F 1487, this means the "vertical distance between a designated play surface and the protective surface beneath it." The fall height of playground equipment should not exceed the Critical Height of the protective surfacing beneath it.

- D. Use Zone: According to ASTM F 1487, the "area beneath and immediately adjacent to a play structure or equipment that is designated for unrestricted circulation around the equipment and on whose surface it is predicted that a user would land when falling from or exiting the equipment."

1.4 PERFORMANCE REQUIREMENTS

- A. Impact Attenuation: According to ASTM F 1292.
- B. Accessibility of Surface Systems: According to ASTM F 1951.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For each playground surface system, include materials, plans, cross sections, drainage, installation, color pattern and edge termination.
- C. Samples for Initial Selection: For each type of playground surface system indicated.
 - 1. Include similar Samples of playground surface system and accessories involving color selection.
- D. Samples for Verification: For each type of playground surface system indicated
 - 1. Minimum 6" x 6" square sample of unitary synthetic seamless surface
- E. Product Schedule: For playground surface systems.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer and testing agency.
- B. Material Certificates: For each type of loose-fill playground surface system, from manufacturer.
- C. Installer Certificates: signed by manufacturer certifying that the installer complies with requirements.
- D. Material Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each loose-fill playground surface system.
- E. Product Certificates: For each type of unitary synthetic playground surface system, from manufacturer.
- F. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each unitary synthetic playground surface system.
- G. Field quality-control reports.
- H. Warranty: Sample of special warranty.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For playground surface system to include in maintenance manuals.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: An experience installer who has specialized in installing work similar in material, design and extent to that indicated for this Project and whose work has resulted in installations with a record of successful in-service performance.
 - 1. Engage in installer who employer of workers trained and approved by manufacturer.
- B. Source Limitations: Obtain playground surface system materials including primers and binders, from single source from single manufacturer.
 - 1. Provide secondary materials including adhesives, primers, geosynthetics and repair materials of type and from source recommended by manufacturer of playground surface system materials.
- C. Standards and Guidelines: Comply with CPSC No. 325, "Handbook for Public Playground Safety"; ASTM F 1292; and ASTM F 1487.
- D. Testing Agency Qualifications: An independent agency qualified according to ANSI Z34.1 for testing, as documented according to ASTM E 548

1.9 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit playground surface system installation to be performed according to manufacturers' written instructions and warranty requirements.
- B. Environmental Limitations: Do not apply playground surface system materials or components over wet, frozen or excessively damp substrates if prohibited by manufacturer's written instructions or warranty requirements.

1.10 COORDINATION

- A. Coordinate installation of playground surface system with installation of other adjacent courtyard improvements.

1.11 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of playground surface system that fails in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Reduction in impact attenuation.

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- b. Deterioration of surface and other materials beyond normal weathering.
2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 UNITARY SYNTHETIC DUAL-DENSITY SEAMLESS SURFACE

- A. Surface System: Poured-in-place, two-layer system with wearing course over cushion course. Provide manufacturer's standard thickness for each layer as required for overall thickness indicated, tested for impact attenuation according to ASTM F 1292 and for accessibility according to ASTM F 1951.
 1. Products: Subject to compliance with requirements, provide the following:
 - a. Safety Turf, Inc., Oaks PA (610) 666-0967.
 - b. or approved equal
 2. Poured Top Layer: TPV rubber granules (1-4mm size).
 3. Poured Base Layer: A precise combination of recycled tire buffing mixed on site with a MDI based polyurethane binder.
 4. Critical Height: 4 feet
 5. Overall Thickness: Total minimum depth of the safety surface will be 2". **The thickness may be adjusted to meet the fall height requirements noted in section 1.6, and the thickness must be adjusted per fall height requirements as specified by play equipment manufacturer.**
 6. Wearing Course Color(s):
 - a. Colors: See drawings for colors and patterns.
- B. Leveling and Patching Material: Portland cement-based grout or epoxy- or polyurethane-based formulation suitable for exterior use and approved by playground surface system manufacturer.

2.2 PLAYGROUND SURFACE SYSTEM, GENERAL

- A. Accessibility: Provide playground surface system that is determined to be accessible when tested according to ASTM F 1951 and designed to comply with requirements for an accessible route as recommended by the ADA Accessibility Guidelines for Buildings and Facilities. (ADAAG).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for maximum moisture content, subgrade and substrate conditions, drainage, and other conditions affecting performance of the Work.

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- B. Hard-Surface Substrates: Verify that substrates are satisfactory for unitary playground surface system installation and that substrate surfaces are dry, cured, and uniformly sloped to drain within recommended tolerances according to playground surface system manufacturer's written requirements for cross-section profile.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. General: Prepare substrates to receive surfacing products according to playground surface system manufacturer's written instructions. Verify that substrates are sound and without high spots, ridges, holes, and depressions.

3.3 INSTALLATION, GENERAL

- A. General: Comply with playground surface system manufacturer's written installation instructions. Install playground surface system over area and in thickness indicated.

3.4 INSTALLATION OF SEAMLESS PLAYGROUND SURFACE SYSTEMS

- A. Seamless Surface: Mix and apply components of playground surface system according to manufacturer's written instructions to produce a uniform, monolithic wearing surface and impact-attenuating system of total thickness indicated.
 - 1. Poured Base Layer - The 1 ½" min. layer of recycled tire buffing will be mixed on site with a MDI based polyurethane binder in a mortar mixer. Mix buffing until they are coated uniformly.
 - 2. This layer will be poured in place by means of a screed and hand trowel. Edge conditions shall be per project requirements. The minimum temperature requirement for installation of the base layer is 40 degrees and rising. Cure time increases at lower temperatures and humidity. (Note: This layer will be adjusted to the correct thickness per fall height requirements)
 - 3. Poured Top Layer - The 1/2" poured top layer shall be composed of TPV granular rubber. The TPV rubber is mixed on site with a MDI polyurethane binder in a mortar mixer. Mix granules until they are coated uniformly. The top layer will be poured-in-place and hand trowel or rolled. If the safety matting is installed over existing asphalt or concrete, the TPV granules will be troweled into the keyway to provide a smooth transition from the existing surface onto the safety matting. The minimum temperature requirement for installation of the top layer is 50 degrees and rising. Cure time increases at lower temperatures and humidity. Day seam may be required for areas greater than 3,000 square feet.
 - 4. Edges- Surface edges shall be flush with the edge of adjacent area, or be such that there is a smooth transition onto the safety matting from the existing surface, or per owner's requirements.
 - 5. Porosity - Surface shall be porous to the extent of allowing the equivalent of 12" per hour of rainfall to flow through it.
 - 6. Traction - Surface shall be non-skid, wet or dry.
 - 7. Softness- Surface deflection with a 30 lb. Load shall be ¼" to ½" with 99% recovery.
 - 8. Health & Environment After Curing - Surface shall be non-toxic, non-allergenic and non-polluting.

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9. Edge Treatment: Saw-cut base and vertical pour. Fully adhere edges to substrate with full coverage of substrate. Maintain fully cushioned thickness required to comply with safety performance requirements.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Testing Services: Testing and inspecting of completed applications of playground surface system shall take place according to ASTM F 1292.
- C. Remove and replace applications of playground surface system where test results indicate that it does not comply with requirements.
- D. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with requirements.

3.6 PROTECTION

- A. Seamless Systems: Prevent traffic over system for not less than 48 hours after installation. Protect playground surface system from damage and wear during the remainder of construction period. Clean playground surface system after time period recommended in writing by playground surface system manufacturer but not more than four days before dates scheduled for inspections intended to establish date of Substantial Completion. Use cleaning materials and procedures recommended in writing by playground surface system manufacturer.

END OF SECTION

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SECTION 32 31 19.1
DECORATIVE METAL FENCES AND GATES FOR LANDSCAPING

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. The contractor shall provide all labor, materials, and appurtenances necessary for installation of the commercial aluminum fence system defined herein at the Summit Campus Courtyard.

1.2 RELATED WORK

- A. Section 31 20 00 – Earth Moving
- B. Section 03 30 05 – Cast-in-Place Concrete for Landscaping

1.3 SYSTEM DESCRIPTION

- A. The manufacturer shall supply a total fence system of Jerith Premier® Aluminum, style #202, 8' panel 3-rail design. The system shall include all components (i.e., panels, posts, gate, and hardware) required.

1.4 QUALITY ASSURANCE

- A. The contractor shall provide laborers and supervisors who are thoroughly familiar with the type of construction involved and materials and techniques specified.

1.5 REFERENCES

- A. ASTM B117 – Practice for Operating Salt Spray (Fog) Apparatus
- B. ASTM B221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles & Tubes
- C. ASTM B85 – Standard Specification for Aluminum-Alloy Die Castings
- D. ASTM D2247 – Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity
- E. ASTM F2957 – Specification for Ornamental Aluminum Fence Systems

1.6 SUBMITTAL

- A. The manufacturer's submittal package including literature shall be submitted prior to installation to confirm compliance with all requirements for materials specified in this section.

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1.7 PRODUCT HANDLING AND STORAGE

- A. Upon receipt at the job site, all materials shall be checked to ensure that no damage occurred during shipping or handling. Materials shall be stored in such a manner to ensure proper ventilation and drainage, and to protect against damage, weather, vandalism, and theft.

1.08 PRODUCT WARRANTY

- A. All fence components (i.e., rails, pickets, and posts) shall be warranted limited lifetime as specified within the product warranty document. Warranty shall cover any defects in workmanship and material finish including cracking, peeling, chipping, blistering, or corroding.

PART 2 – MATERIALS

2.1 MANUFACTURER

- A. The manufacturer shall supply a total fence system of Jerith Premier® Aluminum, style #202, 8' panel, 3-rail design, manufactured by Jerith Manufacturing LLC, Philadelphia, PA. Fence height to be 3'-6".

2.2 MATERIAL

- A. Material for fence framework (i.e., pickets, rails, and posts) shall be extruded from HS-35™ aluminum alloy conforming to the requirements of ASTM B221. Aluminum extrusions for posts and rails shall be alloy and temper designation 6005-T5 with a minimum yield strength of 35,000 psi. The aluminum extrusions for pickets shall be alloy and temper designation 6063-T5 with a minimum yield strength of 25,000 psi.
- B. Pickets shall be 3/4" square x .050" thick. Horizontal rails shall be 1-1/2" (.080 side wall) x 1" (.055" top wall) profile.
- C. At every picket to rail intersection, pickets shall be affixed to rails using stainless steel fasteners. Rail to post connections shall be made using stainless steel screws with heads painted to match the color of the fence.
- D. Accessories: Aluminum castings shall be used for all post caps, scrolls, finials, and other miscellaneous hardware and conforming to the requirements of ASTM B85 for superior corrosion resistance. Hinges and latches shall be fabricated from aluminum, stainless steel, or composite materials.

2.3 Finish

- A. The manufactured fence system shall be subjected to the Jerith FencCoat™ coating process. This multi-phase coating process includes a three-stage pretreatment for uniform chemical conversion resulting in superior adhesion, followed by an electrostatic spray application of TGIC polyester powder for a cured minimum thickness of 2 mils (0.0508mm). The color shall be Black. The multi-layered powder coated fence system shall be capable of meeting the performance requirements for each quality characteristic shown in Table 2.

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2.4 FABRICATION

- A. Horizontal rails shall be punched to accept pickets. There shall be a minimum 3 rails for each fence section, with the exception of style #000 (4' height). Pickets shall be pre-punched to accept rail to picket connection. Pickets shall be affixed to rails using stainless steel screws. Posts shall be pre-punched to accept fence section rails. Rails shall be affixed to post using manufacturer provided fasteners at every intersection. Die cast aluminum caps shall be provided with all posts. Fence posts and gate posts shall meet the minimum size requirements of Table 1.
- B. Gates shall be of welded construction with welds at every picket to rail intersection and rail to gate upright intersection. Gates shall be capable of supporting a 250 lb. vertical load without permanent deformation. Gate height shall be 3'-6", and gate width to be 4'-0".
- C. Assembled sections shall be capable of supporting a 350 lb. vertical load at the midpoint of any horizontal rail without permanent deformation.
- D. Fence system shall meet minimum requirements within ASTM F2957.

PART 3 – EXECUTION

3.11 PREPARATION

- A. All new installation shall be laid out by the contractor in accordance with the construction plans.

3.2 FENCE INSTALLATION

- A. Fence post shall be spaced according to Table 3. For installations that must be raked to follow sloping grades, the post spacing dimension must be measured along the grade. Fence panels rails shall be inserted into punched posts and affixed with fasteners. Posts shall be set in concrete footers per manufacturers' recommendations. The "Earth Moving" and "Concrete" sections of this specification shall govern material requirements for the concrete footer. Posts setting by other methods such as plated posts or grouted core-drilled footers are permissible only if shown by engineering analysis to be sufficient in strength for the intended application.

3.3 FENCE INSTALLATION MAINTENANCE

- A. When cutting/drilling rails or posts adhere to the following steps to seal the exposed surfaces; 1) Remove all metal shavings from cut area. 2) Apply custom finish paint matching fence color. Failure to seal exposed surfaces per steps 1 & 2 above will negate warranty. Spray cans or paint pens shall be used to finish exposed surfaces; it is recommended that paint pens be used to prevent overspray. Use of non-Jerith parts or components will negate the manufactures' warranty.

3.4 GATE INSTALLATION

- A. Gate posts shall be spaced according to the manufacturers' gate drawings, dependent on standard out-to-out gate leaf dimensions and gate hardware selected. Type and quantity of gate hinges shall be based on the application, weight, height, and number of gate cycles. The manufacturers' gate drawings shall identify the

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necessary gate hardware required for the application. Gate hardware shall be provided by the manufacture of the gate and shall be installed per manufacturer's recommendations.

3.5 CLEANING

- A. The contractor shall clean the jobsite of excess materials; post-hole excavations shall be removed from the site.

Table 1 – Jerith Premier Minimum Post Size	
<u>Fence Height</u>	<u>Fence Posts</u>
Up to 6' Height	2-1/2" x 2-1/2" x .075" Aluminum
<u>Gate Leaf</u>	<u>Gate Height - Up to & Including 6' height</u>
Up to 6' width	2-1/2" x 2-1/2" x .125" Aluminum

Table 2 – Jerith Premier Coating Performance Requirements		
<u>Quality Characteristics</u>	<u>Method</u>	<u>Performance Requirements</u>
Humidity resistance	ASTM D2247	Humidity resistance over 3000 hours
Corrosion Resistance	ASTM B117	Corrosion Resistance over 3000 hours

Table 3 – Jerith Premier Post Spacing (punched posts)	
Span	
Post Settings	72-1/2" on center
*Note: When using adjustable wall mount brackets on either or both ends of a fence section installation, care must be taken to ensure spacing between post and adjoining pickets meets applicable codes. This may require trimming one or both ends of the panel.	

END OF SECTION

SECTION 32 91 13 PLANTING PREPARATION

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 SUMMARY

- A. The Work of this Section includes but is not limited to the following:
1. Examination, preparation, and approval of subgrade in lawn and planting areas prior to placement of planting soil mix.
 2. Preparation and placement of planting soil mix in lawn and planting areas.
 3. Guarantee
 4. Disposal and Clean-up

1.3 REFERENCES

- A. The following references apply to this section.
1. Agricultural Chemist: qualified, experienced public or private soils testing laboratory, capable of providing test results as specified and approved by Sikora Wells Appel.
 2. Modified proctor density in accordance with ASTM 01557 (ASTM: American Society for Testing and Materials).
 3. Modified Proctor Density in accordance with AASHTO T180 (AASHTO: American Association of State Highway and Transportation Officials).

1.4 DEFINITIONS

- A. Topsoil is defined as the topmost layer of earth, which produces heavy growths of crops, grass or other vegetation, and is free from clay lumps and toxic substances harmful to plant growth.
- B. Planting Soil is topsoil that has been enriched with nutrients to increase the quality of the soil for planting areas.

1.5 SUBMITTALS

- A. General: Make submittals in accordance with Project Submittal Procedures.
1. Approval by Sikora Wells Appel of submitted product data, samples, test reports, and certificates does not constitute final acceptance.
- B. Testing: Submit written statement from proposed agricultural chemist that required tests can be performed in accordance with the specifications.

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- C. Product Data: Submit product literature or tear sheets giving name of product, manufacturer's name, and compliance with specifications.
1. Compost: Include pH, content of woody material, water absorbing capacity, and moisture content by weight.
 2. Ground Limestone: Include guaranteed analysis and weight for packaged material.
 3. Dehydrated cow manure. Include guarantee that cow manure is pure, sterilized, organic cow manure that is well composted and not fresh.
 4. Fertilizer
- D. Soil Import Mixture: Submit product spec sheets from Supplier if soil is to be imported.
- E. Samples
1. Sand: Two-pound bag.
 2. Compost: One-pound bag.
- F. Test Reports: Submit certified reports by an agricultural chemist. Make submittals at least three (3) weeks following stockpiling of soil on-site.
1. Topsoil: Test all topsoil stockpiled on-site, for compliance with material specifications (See 2.1 A of this Section). Have one composite sample tested from each stockpile intended for use in lawn and planting work. Include the costs of tests and amendments, if required, in the bid price. The Department reserves the right to have soil tested independently.
 - a. If topsoil does not meet specified requirements, submit a program of amendments for bringing the topsoil up to the minimum standards.
 - b. Perform the following tests:
 - 1) Fertility analysis - pH, soluble salts, nitrate, phosphate, potassium, calcium, and magnesium.
 - 2) Cation exchange capacity.
 - 3) Organic matter content (% oven-dry weight of soil).
 - 4) Particle size analysis.
 - c. Promptly submit written reports of each sample tested. Each report shall include:
 - 1) Date issued.
 - 2) Project title and Landscape Trade Contractor name.
 - 3) Testing laboratory name shall be:
 - a) Rutgers Soil Testing Laboratory
Rutgers, The State University of New Jersey
57 US Highway 1
New Brunswick, NJ 08901-8554
Phone: 848-932-9295
Email: soiltest@njaes.rutgers.edu
 - 4) Date and time of sampling or test including temperature and weather conditions.
 - 5) Location of topsoil stockpile or off-site source.
 - 6) Type of test.
 - 7) Results of tests and interpretation of test results.
 - 8) Recommendations for soil additives, proportions, and methods for preparing soil for optimum lawn and planting conditions.
 2. Sand: Provide sieve analysis report and salt content.

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1.6 QUALITY ASSURANCE

- A. Testing shall be performed by a single laboratory.
- B. Installer: Perform Work with personnel totally familiar with planting soil preparation and lawns and planting installation under the supervision of an experienced landscape foreman. Notify the Construction Manager of the name and phone number of the foreman five (5) business days in advance of the first day of lawn construction.
- C. Arrange a pre-construction meeting between Sikora Wells Appel, The School District, and Landscape Contractor. Such meeting shall seek to review the soil testing and soil work schedule, phasing, review of specifications, and construction procedures.

1.7 REGULATORY REQUIREMENTS

- A. Comply with all rules, regulations, laws, and ordinances of local, State, and Federal authorities having jurisdiction. Provide labor, materials, equipment, and services necessary to make Work comply with such requirements without additional cost to the Department.
- B. Investigate the conditions of public thoroughfares and roads as to availability, clearances, loads, limits, restrictions, and other limitations affecting transportation to and ingress and egress at the site. Conform to all governmental regulations regarding the transportation of materials.
- C. Procure and pay for permits and licenses required for Work.

1.8 DELIVERY, STORAGE AND HANDLING

- A. All stockpiled topsoil shall be protected from erosion. Provide temporary seeding and/or erosion control measures.
- B. Before topsoil is redistributed from topsoil stockpiles to areas where planting soil mix is being prepared, re-handle and re-pile stockpiled topsoil in the following manner:
 - 1. Homogenize the topsoil to make a uniform mix, free of subsoil lenses and other irregularities.
 - 2. Aerate the topsoil to make a friable planting medium.
 - 3. Separate out all clay lumps, stone, stocks, and other debris.

1.9 PROJECT CONDITIONS

- A. Environmental Requirements: Perform soil work only during suitable weather conditions. Do not disc, rototill, or work soil when frozen, excessively wet, or in otherwise unsatisfactory condition.
- B. Existing Conditions
 - 1. Carefully examine the site before submitting a bid. Be informed as to the nature and location of the Work, general and local conditions including climate, adjacent properties and utilities, conformation of the ground, the nature of subsurface conditions, the character of equipment, and facilities needed prior to and during execution of the Work.

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2. Shall the Landscape Contractor in the course of Work find any discrepancies between drawings and physical conditions or any omissions or errors in drawings or in layout as furnished by Sikora Wells Appel, it will be his duty to inform the School District immediately in writing for clarification. Work done after such discovery unless authorized by the Department shall be done at the Landscape Contractor's risk.

1.10 SEQUENCING AND SCHEDULING

- A. Coordinate Work of this section with Work of all other sections of specification.
- B. Coordinate earthwork, soil preparation, and lawn and plant installation. Do not allow subgrade, topsoil or planting soil mix to be exposed for longer than 15 days without temporary or permanent cover or other erosion control cover.

1.11 GUARANTEE

- A. The Landscape Contractor shall obtain in the School Districts name the standard written manufacturer's guarantee of all materials furnished under this section where such guarantees are offered in the manufacturer's published product data. All these guarantees shall be in addition to and not in lieu of other liabilities which the Landscape Contractor may have by law or other provision of the contract Documents.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Topsoil: Topsoil acquired from off-site, plus required additives. In the event that stockpiled topsoil from existing site shall be depleted, off-site topsoil shall be acquired in accordance with all applicable federal, state, and local regulations.
- B. The contractor shall notify the Sikora Wells Appel or the School District in the event requiring the importing of topsoil from off-site.
- C. Approved salvaged on-site topsoil shall meet the following minimum requirements:
 1. Topsoil shall be fertile, friable, well drained, pH range of 6.0 to 6.5, free of sub-soil, toxic substances harmful to plant growth, without clay lumps, stones, roots, or debris. Analysis of content shall be as follows:

Sand	35% to 40%
Clay	15% to 20%
Organic Matter	2.5% Minimum
Silt	Balance

2. Where deemed necessary following the testing of on-site stockpiled soil, off-site topsoil shall be tested by the approved soil testing laboratory. A copy of the test report shall be submitted for approval.
3. A sample of the topsoil from each source shall be submitted by the Landscape Contractor to a private testing laboratory for testing and analysis. No topsoil shall be delivered to

the site until test results have been received and approved by Sikora Wells Appel and any and all amendments have been made as necessary to comply with the results of the tests.

4. Chemical Analysis
 - a. Organic matter content (% oven-dry weight of soil)
 - 1) Soil Reaction (pH) 6.1 to 8.4
 - 2) Soluble salt content (conductivity) Less than 5.0 dS/m for a 1:2 soil:water ratio.
5. Nutrient Analysis: Have nutrient levels (nitrate, nitrogen, phosphorous, potassium, magnesium, calcium, etc.) tested and request testing laboratory recommendations for fertilizer requirements for lawn areas and planting areas if nutrient levels are below average.

2.2 SOIL AMENDMENT MATERIALS

- A. Ground Limestone: Minimum of 88% of calcium and magnesium carbonates. Total of 100% passing the 10 mesh sieve; minimum of 90% passing the 20 mesh sieve; minimum of 60% passing the 100 mesh sieve.
- B. Water: Potable, clean, fresh, and free from harmful materials. Water shall be furnished by the Department. Provide all hoses and other irrigation equipment required by the Work shall be furnished by the Landscape Contractor.
- C. Lawn Fertilizer: Complete fertilizer recommended for grass and a standard product complying with State and Federal Fertilizer laws. Deliver fertilizer to the site in the original unopened containers bearing the manufacturer's name and guaranteed statement of analysis. At least 50% by weight of the nitrogen content of the fertilizer derived from organic materials, of the following preparation unless otherwise indicated by topsoil test results:
 1. Nitrogen: 10%
 2. Phosphorus: 20%
 3. Potash: 10%
- D. Sand: Natural, medium to coarse grained in texture, free from decomposed organic matter like roots, sticks, leaves, paper, and of any other undesirable trash like glass, plastic, or metal fragments that could interfere with soil drainage and planting operations. Sand shall be salt free.

2.3 ORGANIC MATTER

- A. All compost is to be US Composting Council-STA certified.
- B. Organic Content: Compost used for soil amendment should be 35%-65% organic content by dry weight.
- C. Maturity Test: Seeding germination and vigor should be >80% of the control.
- D. Salts: Soil conductivity shall be between 2.0 dS/m and 6 ds/m.
- E. Carbon: Nitrogen ration should be 14-20 for soil.

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- F. Physical contaminants: Organic matter shall be free of physical contaminants including metal, glass, plastic, fabric, and plastic films.
- G. Stability: The stability of the organic matter shall be rated very stable based on CO2 respiration to avoid problems with plant growth, odor, and fungus.
- H. Pathogens and metals: Use USEPA standards for Class A Biosolids, or State Standards.
- I. Moisture Content: Organic matter shall contain a range of 35-55% moisture for ease of spreading and cultivation.

PART 3 - EXECUTION

3.1 STOCKPILING, AND STABILIZING PLANTING SOIL MIX

- A. Stockpile planting soil mix in one or more approved locations on the site, or adjacent to the site.
- B. If not used within two weeks after stockpiling, stabilize stockpiled planting soil mix by netting or other covering, and maintain in non-eroding and non-dusting conditions (See Civil Engineering Drawings and Specifications for details).
- C. Surplus planting soil mix, if any, at completion of the Project Work, shall be coordinated with the School District prior to removal.

3.2 PREPARATION OF THE PLANTING SOIL MIX

- A. Existing topsoil that has been stockpiled shall be utilized as a planting medium prior to importing and preparing any planting soil. Testing shall direct the recommended amendments based upon proposed use and application of soil and characteristics of existing soil that is stockpiled for reuse.
- B. For Sodded and Seeded Lawn and Planting Beds
 - 1. 70% topsoil improved as per soil test recommendations.
 - 2. 20% compost.
 - 3. 10% sand.
 - 4. Bring to pH of 6.0 to 6.5. Verify pH by testing.
 - 5. Bring to pH of 5.0 to 5.5 for non-herbaceous plants. Verify pH by testing.
 - 6. Uniformly mix ingredients (soil, organic matter, sand) by wind rowing/tilling on an approved hard surface area. Keep organic matter moist during mixing.

3.3 SUBGRADE PREPARATION TO RECEIVE PRESCRIBED SOIL

- A. Site grading and compaction of fill material shall be as specified on Civil Engineering Drawings.
- B. Before the start of grading and excavation, establish the location and extent of underground utilities in the work area. Exercise care of underground utilities during earthwork operations. Perform excavation work near utilities by hand. Protect active utility services uncovered by excavation.

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- C. Prior to dumping and spreading topsoil, verify subgrade elevations and do whatever additional grading is necessary to bring the subgrade to a true, smooth slope parallel to the finished grade for all areas to receive soil.
- D. Do not compact existing subsoil.
- E. Have subgrade observed by the Civil Engineer prior to placing soil. Request observation at least one week in advance. Clean up subgrade and dispose of all debris and garbage prior to observation.
- F. Correct variations, bumps, ridges, depression, and smooth to final subgrade elevation and contours.
- G. Spray all vegetation on subgrade with an emergent weed killer at a rate of application accepted by the Sikora Wells Appel and approved by government agencies with jurisdiction.
- H. Keep unnecessary equipment off the prepared subgrade.
- I. After acceptance of subgrade, loosen subgrade in lawn area by discing or scarifying to a depth of at least 6 inches to permit bonding of the topsoil to the subsoil. Additionally, loosen subsoil in shrub/tree planting areas to a depth of 2 feet and then roll lightly to help soil settle. Do not compact to greater than 85% density as determined by the Modified Proctor Test. For subsoil or fill that has been compacted to greater the 85% (by any means), loosen top 18" to a range of 80-85% maximum dry density. Within canopies of existing trees, loosen soil to a maximum depth of 2 inches by hand method.

3.4 PLACING PLANTING SOIL MIX

- A. Lawn Areas
 - 1. Place and spread planting soil mix in sodded lawn areas where indicated on Contract Drawings.
 - 2. Provide sufficient planting soil mix so that after cleaning, light rolling and settlement soil will have uniform minimum specified depth.
- B. Planted Areas and Tree Pits
 - 1. Place and spread planting soil mix in Planting areas where indicated on Contract Drawings with the specified depth as indicated in section 3.6
 - 2. Provide sufficient planting soil mix so that after settlement soil will have uniform minimum specified depth.

3.5 PLANTING SOIL MIX AMENDMENTS FOR LAWN AREA

- A. Applying Fertilizer: Apply commercial fertilizer and work thoroughly into the top two (2) inches of the planting soil mix within one week before sodding at the rate of 35 pounds per 1,000 square feet or at rate determined by soil test results.
- B. Applying Limestone: Apply limestone to bring the pH to range of 6.5 to 7.0 at rate determined by the soil test results.

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3.6 PLANTING SOIL MIX DEPTHS

- A. For Sodded and seeded Lawns - minimum 6-inch depth.
- B. For Other Planted Areas -
 - 1. Planting Bed Mix - planting soil mix with a minimum depth of 18 inches shall be installed. In areas of the planting bed mix containing trees, soil depth shall reach a depth of 24" with a minimum radius of 2 1/2x the root ball around trunk locations.
 - 2. If applicable, meadow areas shall be unimproved topsoil placed with a depth of 6".
 - 3. If applicable, shrub massing within rain gardens/ basins: see Civil Engineering plans and details for specific soils requirements in basins.

3.7 DISPOSAL AND CLEANUP

- A. Legally dispose of off-site all refuse and debris from these operations. Do not dump or burn materials on site.
- B. Maintain the site in an orderly condition during the progress of the Work. Continuously and promptly remove excess waste materials; keep lawn areas, walks, and roads clear. Store materials and equipment where directed. Promptly remove equipment, surplus materials, debris, and trash resulting from operations under this contract upon completion and prior to initial acceptance of Work. Leave the site in a neat, orderly condition, "broom clean."

END OF SECTION

SECTION 32 92 00 TURF & GRASSES

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 SUMMARY

- A. Work of this Section includes all labor, materials, equipment and services necessary to complete the project coordination and installation of lawn and grasses as specified herein, including but not limited to the following:
 - 1. Review and acceptance of sub-grade and planting soil mix prepared and placed as per Section 312000 – Earth Moving and Section 329113 – Planting Preparation.
 - 2. Amending of planting soil
 - 3. Installation of sodded lawn.
 - 4. Protecting and maintaining all seeded and sodded areas until Substantial Completion.
 - 5. Provide and install erosion control fabric as required on all slopes 3:1 or greater, swale bottoms and around inlets as indicated.
 - 6. Final clean-up
- B. Related Sections include the following:
 - 1. Section 312000 Earth Moving
 - 2. Section 312500 Soil Erosion and Sediment Control
 - 3. Section 329113 Planting Preparation
 - 4. Section 329300 Plants

1.3 SUBMITTALS

- A. General: Make submittals in accordance with Section 013300 Submittal Procedures.
- B. Qualifications
 - 1. Submit qualifications of the entity and its workers performing the Work of this Section to Sikora Wells Appel in accordance with 1.4 A. Include names of clients, telephone numbers, and contract amounts for work performed in the last three years, and experience records of workers performing the Work of this Section and evidence of license of pesticide applicator.
- C. Product Data: Submit product literature or tear sheets giving name of product, manufacturer's name, and compliance with specifications.
 - 1. Fertilizer

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2. Ground Limestone
3. Weed Control/Glyphosate
4. Wood Cellulose Fiber Mulch
5. Erosion Control Blanket

D. Certification

1. Submit sod certification, in accordance with the requirements of 1.4 C.

E. Schedule and Work Plan

1. Submit detailed schedule and work plan, indicating location and installation dates for each area of lawn and meadow seeding.

F. Maintenance Program

1. Submit a program for continued maintenance of lawn areas after Substantial Completion. Program shall include a report of conditions unique to site that have been identified during contractor's maintenance of lawn areas.

1.4 DESIGN PERFORMANCE REQUIREMENTS

- A. Use product-testing methods adopted and published by the Association of Official Analytical Chemists, 1111 19th Street, Suite 210, Arlington, VA 22209.
- B. Fertilizers shall conform to current standards as established by the Association of American Plant Food control Officials, Inc., Division of Regulatory Services, University of Kentucky, Lexington, KY 40546.
- C. Base standards for weather conditions on reports on the weather radio band of the National Oceanic and Atmospheric Administration, Washington Science Center, Rockville, MD 20852, and on its publication entitled "Local Climatological Data With Comparative Data", published 12 times a year as a monthly and once a year as an annual.
- D. Sod shall conform to current standards established by the American Sod Producers Association, 1855-A Hicks Road, Rolling Meadow, IL 60008.
- E. All cultural requirements for turf grass shall be in accordance with the "Cornell Cultural Recommendations for Commercial Turfgrass Management", current edition, published by Cornell University, Ithaca, NY 14850.

1.5 QUALITY ASSURANCE

A. Qualifications

1. The entity and its workers performing the Work of the Section shall be experienced in landscaping and have been engaged in work of a complexity similar to that required under this Section for a period of at least five (5) years.

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2. Installation personnel shall be under the supervision of an experienced landscape foreman at all times during construction. Notify Sikora Wells Appel of the name and phone number of foreman five (5) business days in advance of the first day of lawn construction.
3. The entity performing pesticide applications shall be licensed as a commercial applicator by the state in which the Work is being performed.

B. General Requirements for Operations and Products

1. Products listed in PART 2 – PRODUCTS shall be approved in writing by Sikora Wells Appel prior to delivery to the construction site.
2. After delivery to the construction site, the General Contractor may, at his discretion, take for analysis representative samples of any item listed in PART 2 – PRODUCTS.
3. Pesticide
 - a. Select to act on identified pest and use the manufacturer's recommended formula, application rate and safety instructions at all times.
 - b. Mix and agitate products and use equipment according to the manufacturer's directions. Mix and agitate at the work site only in a work area designated by the General Contractor.
 - c. Dispose of spills and surplus products away from project property.
 - d. Keep all records that are or maybe required by Federal, State or Local laws. Submit copies of these records to the General Contractor within 5 days when so requested.
 - e. Not less than forty-eight (48) hours prior to a proposed spray operation, submit to the General Contractor for his approval, a tabulated list indicating the target to be treated, the chemical trade name and quantity of mix being prepared.

C. Specific Requirements for Operations and Products

1. Each sod shipment shall be certified by Federal and State Authorities to be free of insects and diseases. Inspection certificates to this effect shall accompany each shipment invoice and shall be delivered to the General Contractor.

D. Resodding

1. Replace unsatisfactory sodded areas for a period of six months from the date on which the Certificate of Final Completion is issued. Resod all areas that are dead or have weed and/or pest infestations.
2. Perform replacement of unsatisfactory sod with products and by operations that comply with all requirements of these Specifications, and on such date(s) as ordered by the General Contractor.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver all products in the manufacturer's unopened containers bearing the trade name, manufacturer's name, weight and analysis.
- B. Store products away from moisture and extreme temperatures and in such a manner that their effectiveness will not be impaired.

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C. Formulation, Application and Equipment

1. Use the manufacturer's recommended formula, application rate and safety instructions at all times.
2. Dispose of spilled materials and surplus products away from project property.

D. Specific Requirements for Sod

1. Harvest, deliver and transplant within a 36-hour period. Before harvesting, mow uniformly to a height of 1 1/2 inches.
2. Do not store sod on the construction site. Install upon delivery.
3. Do not install sod that turns yellow during handling or delivery.

1.7 REGULATORY REQUIREMENTS / PERMITS AND CODES

- A. Comply with all rules, regulations, laws and ordinances of local, state and federal authorities having jurisdiction. Provide labor, materials, equipment and services necessary to make Work comply with such requirements without additional cost to the School District.
- B. Investigate the conditions of public thoroughfares and roads as to availability, clearances, loads, limits, restrictions, and other limitations affecting transportation to and ingress and egress at the site. Conform to all governmental regulations regarding the transportation of materials and secure, in advance, any necessary permits.
- C. Procure and pay for permits and licenses required for Work.

1.8 EXAMINATION OF SITE AND DOCUMENTS

- A. Existing conditions:
 1. Carefully examine the site before submitting a bid. Be informed as to the nature and location of the Work, general and local conditions including climate, adjacent properties and utilities, conformation of the ground, the nature of subsurface conditions, the character of equipment and facilities needed prior to and during execution of the Work.
 - a. Be aware of and comply with restrictions regarding subsurface utilities and subterranean structures, including excavation and loading parameters.
 2. Shall the Contractor, in the course of Work, find any discrepancies between Drawings and physical conditions or any omissions or errors in Drawings, or in layout as furnished by the Sikora Wells Appel, it will be his duty to inform Sikora Wells Appel immediately in writing for clarification. Work done after such discovery, unless authorized by Sikora Wells Appel, shall be done at the Contractor's risk.
- B. Note areas of Phasing and coordinate sequence of work with locations and limitations of access from these other areas; coordinate with the School District and Sikora Wells Appel.

1.9 ENVIRONMENTAL REQUIREMENTS

- A. Perform operations only during the following weather conditions:

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1. There shall be no frost in the ground and the soil temperature at each sodded area shall be above 32 degrees F.
2. There shall be no form of precipitation falling or forecast to fall within the next two hours. Following a period of precipitation, resume operations only after the soil has drained.
3. Apply chemicals only when wind velocity is below 5 mph, drift hazard is negligible and the air temperature is above 40 degrees F and below 70 degrees F.
4. Do not perform any product application if precipitation has fallen within two hours prior to the planned application time or is forecast during the next 12-hour period.

B. Sodding Calendar Limitations

1. Sodding shall be performed only during the following two (2) periods:
April 1 through April 30
September 1 through October 31.

1.10 SEQUENCING AND SCHEDULING

- A. Coordinate Work of this Section with Work of all other Sections of Specification.

1.11 INSPECTION FOR SUBSTANTIAL COMPLETION

- A. Refer to Conditions of the Contract for provisions regarding guarantees for the Work.
- B. Maintain all lawn areas until Substantial Completion. Maintenance will be in accordance with requirements specified in Part 3 of this Section.
- C. Sikora Wells Appel will make an inspection for Substantial Completion of the Work of this Section at the time of Substantial Completion of the entire Contract. The Contractor shall furnish a full and complete written program for maintenance of the lawns for review by Sikora Wells Appel at the time of the request for Substantial Completion.
1. Submit a written request for inspection at least ten (10) weeks prior to the day on which the inspection is requested.
 2. The Contractor shall prepare a list of items to be completed or corrected for review by Sikora Wells Appel, prior to inspection.
 3. All lawns shall show a uniform, thick, well-developed stand of grass. If the grass stand is unsatisfactory, as determined by Sikora Wells Appel, the Contractor's maintenance responsibility shall continue until an acceptable stand of grass is achieved.
- D. Upon completion of the inspection, Sikora Wells Appel shall amend the list of items to be completed or corrected, and indicate the time period for their completion or correction.
- E. Lawns will not be accepted until all items have been completed or corrected. Sikora Wells Appel, after an additional inspection, shall recommend in writing the Substantial Completion of the Work of this Section. The Contractor's responsibility for maintenance shall terminate, under issuance of a certificate of Substantial Completion for the entire Contract.

1.12 GUARANTEE

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- A. In addition to the specific guarantee requirements of the General Conditions and Supplementary General conditions, the Contractor shall obtain in the Department's name the standard written manufacturer's guarantee of all materials furnished under this Section where such guarantees are offered in the manufacturer's published product data. All these guarantees shall be in addition to, and not in lieu of, other liabilities, which the Contractor may have by law or other provisions of the Contract Documents.

PART 2 - PRODUCTS

2.1 PLANTING SOIL MIX

- A. Planting soil mix for Lawns: See Specification Section 329113 – Planting Preparation.

2.2 SOD

- A. Nursery-grown and cultivated from certified seed containing at least 90% of the seed mix as specified for fine lawn areas, not less than two years old before lifting, uniform in density, natural green color, free of noxious weeds, as supplied by Tuckahoe Turf Farms in Hammonton, NJ (phone no. 609-561-7184) or approved equal.
- B. Sod shall be comprised of the following seed mixes or an approved equal:

<u>Type of Seed</u>	<u>Percentage of Mix</u>
TALL FESCUE (45% of each of the following varieties) Millennium, Plantation.	90%
BLUEGRASS (Tuckahoe Turf Farm Bluegrass Blend)	10%

- C. Machine cut sod before delivery to uniform soil thickness of 3/4 inch plus or minus 1/8 inch at the time of cutting, with grass height at 1 1/2 to 2 inches, wetted before cutting. Obtain approval of sod and certify its grass types and percentages before cutting.
- D. Cut individual pieces of sod 18 inches wide x 60 inches long (7-1/2 sq.ft.). When a section of sod is suspended vertically from a firm grasp on the upper 10% of the section, sod shall be strong enough to support its own weight and retain its size and shape. Do not harvest or transplant sod when moisture content may adversely affect its survival.

2.3 SOIL AMENDMENT MATERIALS

- A. Superphosphate: 0-20-0 as distributed by J&L Adikes, 182-12 93rd Avenue, Queens, NY 11423, or Lebanon Chemical Co., PO Box 180, Lebanon, PA 17042, or approved equal conforming to the following:
1. Formulated fertilizer having a guaranteed analysis as follows:

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0% N
20% P₂O₅
0% K₂O

B. Soil pH Adjustment

1. Granulated dolomitic limestone conforming to the following:
 - a. Total carbonates no less than 86% of 48.2% calcium oxide equivalent. For purposes of calculation, total carbonates shall be considered as calcium oxide. Magnesium oxide content shall be between 15-22%.
 - b. A dust-free, homogenous, granular material.

2.4 WEED CONTROL/GLYPHOSATE

- A. 41% - Glyphosate N – (Phosphonomethyl) glycine
59% - Inert Ingredients

2.5 PROTECTIVE FENCING

- A. All newly sodded areas shall be continuously protected from being disturbed. Where such areas will be subject to pedestrian or vehicular traffic, erect and maintain a four-foot-high polypropylene fence or approved equal.

2.6 WOOD CELLULOSE FIBER MULCH

- A. Shall consist of especially prepared wood cellulose processed into a uniform fibrous physical state. Wood cellulose fiber mulch shall be dyed green or contain a green dye in the package that will provide an appropriate color to facilitate visual inspection of the uniformity spread slurry. The fiber mulch, including dye shall contain no germination or growth inhibiting factors. The mulch material shall be manufactured and processed in such a manner that the wood cellulose fiber mulch will remain in uniform suspension in water under agitation and will blend with other additives to form a homogeneous slurry. The mulch material shall form a blotter-like ground cover, on application, having moisture absorption and percolation properties and shall cover and hold grass seed in contact with the soil without inhibiting the growth of the grass seedlings.
- B. The mulch material shall contain no elements of compounds at concentration levels that will be phyto-toxic. Wood cellulose fiber must conform to the following physical requirements: fiber length to approximately 10mm., diameter approximately 1mm., ph range of 4.0 to 8.5, ash content of 1.6% maximum and water holding capacity of 90% minimum.

2.7 EROSION CONTROL BLANKET

- A. DS75 Agricultural straw matrix stitch bonded with degradable thread to a single UV accelerated photodegradable polypropylene netting as manufactured by North American Green or approved equal.

2.8 WATER

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- A. Water: Potable, clean, fresh and free from harmful materials. Water shall be furnished by the Department. All hoses and other irrigation equipment required for the Work shall be furnished by the Contractor.

PART 3 - EXECUTION

3.1 EXAMINATION OF SITE

- A. Prior to construction of lawn areas, ascertain the location of all electric cables, conduits, underdrainage systems, irrigation and utility lines. Take proper precautions so as not to disturb or damage waterproofing or other sub-surface elements. If Contractor fails to follow this procedure, he is responsible for making requisite repairs to damaged waterproofing and utilities at this own expense.
 - 1. Verify that required underground utilities are available, in proper location and ready for use. Coordinate with other trades.

3.2 PREPARING TOPSOIL

- A. Prepare topsoil as directed in the Soil Preparation spec.
- B. Thoroughly wet down soil areas to be sodded the evening before sod is to be installed.

3.3 INSTALLATION OF SODDED LAWN

- A. Place sod on prepared topsoil bed as herein before specified.
- B. Ensure that the soil areas that are to receive sod are moist but not saturated; soil must not be in a dry, dusty state.
- C. Lightly roll soil areas prior to installing sod to eliminate uneven settlement.
- D. Lay sod with tight joints. Butt ends and sides of strips; do not overlap. Stagger strips to offset joints in adjacent courses. Keep rows parallel with contour lines and true to finished grade. Roll or tamp in place to establish firm contact with the topsoil bed. Water the entire sodded area immediately after placing; apply one inch of water by an approved sprinkling method.
- E. Retain sod on slopes greater than 10% using wooden pins driven into sod until top is flush with sod.

3.4 WATERING OF SODDED LAWN AREAS

- A. Keep newly sodded areas moistened until the grass becomes well established.
- B. In the event of insufficient rainfall, moisten sodded areas daily until rooted. Thereafter, water in absence of rain every seven (7) to ten (10) days. When watering sod, make sure that water soaks through the sod into the topsoil bed below.

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3.5 MOWING OF SODDED LAWN AREAS

- A. The first mowing shall not be attempted until the grass is firmly rooted and secure in place. Not more than one third (1/3) of the grass blade shall be removed by the initial cutting or subsequent cuttings. Mow with a reel-type mower. Continue cutting until Substantial Completion. Grass height shall be maintained between one and one half (1 1/2") inches and two and one half (2 1/2") inches unless otherwise specified.

3.6 PROTECTIVE WORK

- A. All lawn areas shall be continuously protected against damage by a fence as specified herein. It shall be continuously maintained in a condition acceptable to Sikora Wells Appel. This fence and any protective devices remaining on site shall be removed after Substantial Completion unless directed otherwise by Sikora Wells Appel.
- B. The cost of replacement shall be borne by the Contractor except where it can be definitely shown that the loss resulted from vandalism or deleterious effects caused by maintenance procedures performed by the School District without the concurrence of the Contractor. All lawn areas, damaged or disturbed by replacement or repair operations shall be fully restored to their original condition.
- C. Defer work when continuation of construction work must occur over certain lawn areas.

3.7 MAINTENANCE OF LAWN WORK

- A. The Contractor shall maintain all lawn areas in a first-class condition from the beginning of lawn construction until that phase of the project has been reviewed and is accepted by the School District and Sikora Wells Appel. The Contractor shall advise the School District, in writing, when the work is in condition to meet acceptance. After that acceptance, the School District shall maintain the work.
- B. Maintenance shall include, but not be limited to watering of turf, mowing, cultivation, weeding disease and pest control, replacement of dead, stolen or unacceptable materials, filling under settlement areas, and re-sodding or reseeding wash-outs, and any other procedure consistent with good horticultural practice necessary to insure normal, vigorous and healthy growth of all work under this contract.
- C. The Contractor is responsible for the final watering of not less than one (1") inch of water for all lawn areas before leaving the site.
- D. All areas and spots, which do not show a prompt catch of grass, shall then be resodded, and the operation repeated until complete coverage is obtained. When the area does not need to be reseeded, it shall be thoroughly wetted every time the surface shows evidence of drying out, and this shall continue through the entire period of maintenance.
- E. Maintenance shall cease after the third cutting, provided all grass areas are properly established and free of washouts, depressions, bare spots, weeds, and large off-color areas.

3.8 INSPECTION FOR SUBSTANTIAL COMPLETION

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- A. Maintain all lawn areas until Substantial Completion.
- B. Sikora Wells Appel will make an observation for Substantial Completion of the Work of this Section at the time of Substantial Completion of the entire Contract. The Landscape Contractor shall furnish a full and complete written program for maintenance of the lawns for review by Sikora Wells Appel and the School District at the time of the request for Substantial Completion.
 - 1. All lawns shall show a uniform, thick, well-developed stand of grass. If the grass stand is unsatisfactory, as determined by Sikora Wells Appel and the School District, the Landscape Contractor's maintenance responsibility shall continue until an acceptable stand of grass is achieved.
 - 2. Sodded areas shall have been mowed at least twice since time of installation.
 - 3. Sod shall have shown signs of knitting with the topsoil layer and adjoining sod pads. No open joints between sod pads nor sod slippage on slopes will be acceptable.
 - 4. Sod shall be in a thriving and vigorous condition exhibiting a healthy green color.
- C. The Landscape Contractor's responsibility for maintenance shall terminate, under issuance of a certificate of Substantial Completion for the entire Contract.

3.9 CLEAN UP

- A. Maintain the site in an orderly condition during the progress of Work. Continuously and promptly remove excess and waste materials; keep lawn areas, walks and roads clear. Store materials and equipment where directed. Immediately remove rejected materials from the property. Promptly remove equipment, surplus material and debris and trash resulting from operations under this Contract upon completion and prior to inspection of Work. Leave the site in a neat, orderly "broom clean" condition.

END OF SECTION

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SECTION 32 93 00 PLANTS

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 SUMMARY

- A. Work of this Section includes all labor, materials, equipment, and services necessary to furnish, deliver, and install the following:

1. Furnishing and installing trees, shrubs, ground covers, and perennials.
2. Guying
3. Staking
4. Mulching
5. Fertilizing
6. Natural Stone Boulders
7. Guarantee
8. Maintenance
9. Clean Up

- B. Related Sections include the following:

1. Section 329113 Planting Preparation
2. Section 329200 Turf and Grasses
3. Section 329400 Seeding and Groundcovers

1.3 REFERENCES

- A. The following references apply to this section.

1. ASNA: "American Standard for Nursery Stock," ANSI Z60.1, latest edition, published by the American Association of Nurserymen, (AAN).
2. SPN: "Standardized Plant Names," latest edition, by the American Joint Committee on Horticultural Nomenclature.
3. Agricultural Chemist: Qualified, experienced public or private soils testing laboratory, capable of providing test results as specified and approved by Sikora Wells Appel.

1.4 SUBMITTALS

- A. General: Make submittals in accordance with Section 013300 Submittal Procedures.

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1. Approval by Sikora Wells Appel of submitted product data, samples, test reports, and certificates, or plant material inspected at source of supply, does not constitute final acceptance.
- B. Planting Schedule: Indicating selection trips (to Nursery), delivery and planting dates (includes seasonal plantings) within 90 days of award of a contract. Provide name and location of nursery, contact person, and telephone number.
- C. Product Data: Submit product literature or tear sheets giving name of product, manufacturer's name, and compliance with specifications.
 1. Commercial Fertilizer: Include guarantee analysis and weight for packaged materials.
 2. Herbicides, pesticides, and fungicides: Include safety information.
 3. Anti-desiccant.
- D. Samples (with product data if applicable):
 1. Shredded Hardwood Mulch: Two (2) pound bag
 2. Stone Fines Mulch: Two (2) pound bag
 3. Filter Fabric
 4. Drainage Stone
 5. Stabilized stone screenings: 5lb of stone material selection in sealed, plastic bags. Sample shall be typical of the lot of material to be delivered and installed on the site; provide an accurate indication of color, texture, and makeup of the material.
- E. Photos of Natural Stone Boulders with measuring stick adjacent to boulders for representation of size.
- F. Planting Soil Test Report
- G. Compost Test Report
- H. Certifications: Submit with certificate names of materials and manufacturer.
 1. Plant Material: Furnish certificates of inspection as may be required by Federal, State, or other authorities that plant material is free of disease or hazardous insects.
 2. Bulk Fertilizer Certification
- I. Schedule and Work Plan: Submit detailed schedule and work plan, indicating start and finish dates of planting activities, including layout, soil preparation, delivery of plant material from nursery sources, excavation, and installation. If planting work is being installed in phases, submit plan with definable areas outlined and keyed and provide schedule for planting work within each area.
- J. Qualifications: Submit qualifications of the entity and its workers performing the Work of this Section to Sikora Wells Appel. Include names of clients, telephone numbers, and contract amounts for work performed in the last three (3) years.
- K. Maintenance Program: Submit full and complete written program for maintenance of the planting. Submit prior to observation for Substantial Completion.

1.5 QUALITY ASSURANCE

- A. Landscape Work shall be performed by a single firm specializing in landscape work with a minimum of 5 years of experience on projects of similar scope and size.
- B. Plant Material: Meet or exceed application AAN standards.
 - 1. Plant List: Investigate sources of supply prior to submitting bid. Confirm that size, variety, and quantity of plant material specified on plant list can be supplied. Failure to take this precaution will not relieve the successful bidder from his responsibility for furnishing and installing all plant material in strict accordance with the contract requirements and without additional expense to the Department.
- C. Plant substitutions are permitted only with written approval by Sikora Wells Appel.
- D. Installer: Perform Work with personnel totally familiar with planting techniques under the supervision of an experience landscape foreman. Notify the Department of the name and phone number of the foreman five (5) business days in advance of the first day of planting operations.
- E. Arrange a pre-construction meeting between Sikora Wells Appel, the Department and Landscape Contractor. Such meeting shall seek to review the proposed plant schedule, source of plants, consideration of substitutions, general review of specifications, and planting procedures.

1.6 PLANT SELECTION AND OBSERVATION

- A. Sikora Wells Appel will inspect and tag all trees and at least five shrubs of each species as a representative sample at the source of supply. Trees delivered without tags and shrubs that do not equal the quality of tagged samples will be rejected. The Landscape Contractor or his representative shall locate plant materials and be present for inspection of plants at the source. The Landscape Contractor shall make all pre-selection arrangements at the source of supply to ensure a ready supply of materials, equipment, and manpower required for an efficient selection procedure. Request the visit at least 14 days in advance of the desired observation date.
 - 1. Plants will be inspected and approval given by Sikora Wells Appel at the source for conformity to specification requirements for size and form. Such approval shall not affect the right of inspection and rejection during delivery and installation. Contractor shall inspect the selected plants for disease and other requirements of the Contract Documents.
 - 2. All material specified as balled and burlapped (B&B) must be in the ground at the growing source at the time of inspection. Pre-dug material will not be accepted.
 - 3. Arrange for adequate manpower and equipment on site at the time of plant material inspection and installation to provide a complete staked layout and to unload, open, and handle plant material during inspection.

1.7 REGULATORY REQUIREMENTS

- A. Comply with all rules, regulations, laws, and ordinances of local, State, and Federal authorities having jurisdiction. Provide labor, materials, equipment, and services necessary to make Work comply with such requirements without additional cost to the Department.

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- B. Investigate the conditions of public thoroughfares and roads as to availability, clearances, loads, limits, restrictions, and other limitations affecting transportation to and ingress and egress at the site. Conform to all governmental regulations regarding the transportation of materials.
- C. Procure and pay for permits and licenses required for Work.

1.8 DELIVERY, STORAGE AND HANDLING

- A. Packaged Materials: Deliver packaged materials in clearly marked containers showing net weight, guaranteed analysis and name of manufacturer. Specified requirements for packaged material apply to bulk shipments. Protect material from deterioration during delivery and during storage at site.
- B. Plant Material:
 - 1. Notify Sikora Wells Appel seven (7) days in advance of any delivery of plant materials to the site.
 - 2. Plants shall be of the quantity and quality indicated, true to name, properly labeled with scientific and common name, and in accordance with the sizes and grades specified. Plants shall be nursery-grown, have a habit of growth that is normal for the species, and shall be sound, healthy, vigorous, free from insect pests, plant diseases and injuries, and shall have normal root systems. All plants shall equal or exceed the measurements specified in the plant list, which are minimum acceptable sizes.
 - 3. Upon delivery to the site, all nursery stock shall be planted at once. If this is not feasible, plants shall be heeled in with roots well covered. Protect plants from the sun and wind, and keep roots moist. During the planting operations, the nursery stock shall not be exposed to the sun or to drying wind.
 - 4. Dig and handle plants with care to prevent injury to trunks, branches, and roots.
 - 5. Plants shall be measured before pruning, with branches in normal position. Any necessary pruning shall be done at time of planting. Requirements for the measurement, branching, grading, quality, balling, and burlapping of plants in the plant list shall follow the code of standards currently recommended by the American Association of Nurserymen, Inc., in the American Standard for Nursery Stock, amended to date.
 - 6. Deliver trees and shrubs after preparations of planting areas have been completed and approved and plant immediately.
 - a. If planting is delayed more than 24 hours after delivery, set balled and burlapped plants on the ground well protected with soil, wood chips/wood shavings, or other acceptable materials. Adequately cover all roots of bare root material with soil, wood chips/wood shavings, or other acceptable material. Protect balls and roots and container grown material from freezing, sun, drying winds, and/or mechanical damage. Provide automatic watering system as necessary until planted.
 - b. Heeling in of plants shall not be allowed for more than 3 days without approval of Sikora Wells Appel.
 - 7. Immediately remove rejected plant material from the site.

1.9 PROJECT CONDITIONS

- A. Environmental Requirements: Plant only within the following dates, weather permitting. Do not plant when the ground is frozen or the soil is otherwise in an unsatisfactory condition for planting.

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1. Plant ground covers and balled and burlapped broadleaf evergreens in the spring only between April 1 and June 30.
2. Plant balled and burlapped deciduous trees and needled evergreen trees and shrubs and container grown trees and shrubs between April 1 and June 15 and September 1 and November 15.
3. Plant perennials as soon as the ground is workable in spring until June 15 and between September 1 and November 15.

B. Existing Conditions

1. Carefully examine the site before submitting a bid. Be informed as to the nature and location of the Work, general and local conditions including climate, adjacent properties and utilities, conformation of the ground, the nature of subsurface conditions, the character of equipment, and facilities needed prior to and during execution of the Work.
2. Shall the Landscape Contractor in the course of Work find any discrepancies between drawings and physical conditions or any omissions or errors in drawings or in layout as furnished by Sikora Wells Appel, it will be his duty to inform the Department immediately in writing for clarification. Work done after such discovery unless authorized by Sikora Wells Appel shall be done at the Landscape Contractor's risk.

1.10 SEQUENCING AND SCHEDULING

- A. Coordinate Work of this section with work of all other sections of specification.

1.11 OBSERVATION FOR SUBSTANTIAL COMPLETION

- A. Sikora Wells Appel with the Landscape Contractor will make an observation for Substantial Completion of the Work of this section. The Landscape Contractor shall furnish full and complete written program for maintenance of the planting for review of Sikora Wells Appel at the time of the request for Substantial Completion.
1. Submit a written request for observation at least two (2) weeks prior to the day on which the observation is requested.
 2. All planting shall be alive, healthy, and installed as specified in order to be accepted.
 3. The Landscape Contractor shall prepare a list of items to be completed or corrected for review of Sikora Wells Appel.
- B. Upon completion of the observation, Sikora Wells Appel shall amend the list of items to be completed or corrected and indicate the time period for their completion or correction.
- C. Sikora Wells Appel will make another observation after notification from the Landscape Contractor that all items have been completed and corrected. If the Work is complete and acceptable, Stantec will certify in writing to the Department the Substantial Completion of the Work. The guarantee period will not begin until certification is received by the Department.

PART 2 - PRODUCTS

2.1 PLANT MATERIAL

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- A. Plants furnished shall be nursery-grown stock and comply with USA "Standard for Nursery Stock" for sizes shown. Standardized plant names per American Joint Committee on Horticultural Nomenclature. Deviations there from, if indicated, are intentional.
- B. Source of plant materials shall be within the same plant hardiness zone and having similar climate conditions as the Project area. Zone shall be as defined on the U.S. Department of Agriculture Plant Hardiness Zone Map.
- C. Measure plant material when the branches are in their normal position. No pruning shall be done before the plant materials are delivered to the site. Clipped or sheared plants are not acceptable unless otherwise specified. Plant material shall be natural in habit of growth and be full bodied.
- D. The accuracy of species, varieties and quantities specified for plant material shall be the Landscape Contractor's responsibility. Quantities shown on plan shall take precedence over those shown in plant schedule. Plant schedules (if any) are for Landscape Contractor's convenience.
- E. The Design Professional will accompany the Landscape Contractor on selection trip(s) to the nursery. Design Professional will select plants for proper visual formation. Landscape Contractor shall inspect the selected plants for disease and other requirements of the Contract Documents. Prior to this trip, the Landscape Contractor shall have pre-selected the Nursery(s) to ascertain that sufficient plants in size and specie required are available for proper selection.
- F. The Design Professional will tag all trees and at least five shrubs of each specie as a representative sample. Trees delivered without tags, and shrubs that do not equal the quality of tagged samples, will be rejected.
- G. The contractor shall make every effort to secure trees without wire baskets for use on site. Bid price shall reflect any additional costs for exclusive use of balled and burlapped trees.

2.2 PLANTING SOIL MIX

- A. As specified is Section 329113 – Planting Preparation.

2.3 MULCH

- A. Mulch shall be course fibrous shredded hardwoods, free of dyes, sufficiently aged to prevent adverse reactions to plant material and subject to approval by Sikora Wells Appel.

2.4 NATURAL STONE BOULDERS

- A. Boulders shall be "Karney Chunk Boulders, as supplied by Wicki Wholesale Stone, Inc., Great Meadows, NJ, Phone 908-637-6004.
 - 1. Size Range:
 - a. Height: 18" – 24"
 - b. Width (Varies): 2' through 4'
 - c. Depth (Varies): 2' through 3'
 - 2. Selected boulders shall have a flat top and bottom surfaces suitable for placing level and providing an opportunity for seating.

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2.5 FERTILIZER

- A. Conforming to standards of Association of Official Agricultural Chemists, delivered in sealed and labeled bags, or in bulk with certification as to quality and analysis.

2.6 WATER

- A. Potable, clean, fresh, and free from harmful materials. Water shall be furnished by the Department. All hoses and other irrigation equipment required for the Work shall be furnished by the Landscape Contractor.

2.7 FILTER FABRIC

- A. "TYPAR" Spun bonded Polypropylene, Style 3401 or equivalent.

2.8 ANTI-DESICCANT

- A. "Wilt-Pruf" as manufactured by Nursery Specialty Products of New York, or approved equal.

2.9 ARBORTIE

- A. For all proposed trees, 3/4" Green flat woven polypropylene ArborTie with tensile strength of 900 lbs.

2.10 INSECTICIDE

- A. 5% solution "Cygon", systemic type or approved equal

2.11 METAL EDGING

- A. Border Concepts, Inc. or approved equal
 1. Size: 3/16" thick x 5-1/2" deep.
 2. Series: Border Guard
 3. Material: Steel
 4. Color/Finish: Black
 5. Shape: As shown on drawings

PART 3 - EXECUTION

3.1 General

- A. Coordinate installation of plant material with all other trades (including, but not limited to electrical and plumbing) to ensure that there are no conflicts between location of new site improvements and new plant material. Contact the General Contractor immediately if a conflict is evident prior to planting.
- B. All Work shall be in accordance with standards of the American Association of Nurserymen.

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- C. Verify that site is ready for planting prior to delivery of materials.
- D. Install plants as promptly as possible, preferably the same day as delivered. Upon delivery to site, unless planted the day of delivery, pile earth or mulch around the earth ball so that water evaporation and soil and root drying are kept to a minimum. Keep plant ball moist. Plant materials will be subject to re-inspection before they are planted.
- E. Installation of plant material shall conform to the timetable established with the schedule outlined for the project. Out of season planting shall be at Landscape Contractor's own risk. After the plant material is placed in the planting pit, the top one third 1/3 (minimum) of burlap and twine shall be removed from the root ball at the time of installation and removed from the site.
- F. After the plant material is placed in the planting pit, the top and sides of all wire baskets (if applicable) are to be removed from the root ball and removed from the site. The bottom of the wire basket is not to be removed from the under side of the root ball.
- G. Notify Sikora Wells Appel at least three working days in advance of start of Work.

3.2 EXAMINATION OF SITE

- A. Prior to excavation of planting areas, ascertain the location of all electric cables, conduits, underdrainage systems, and utility lines. Take proper precautions so as not to disturb or damage sub-surface elements. If sub-surface elements are uncovered, promptly notify the Department for relocation. If Landscape Contractor fails to follow this procedure, he is responsible for making requisite repairs to damaged utilities at his own expense.

3.3 PREPARATION OF SUBGRADE

- A. See Section 312000 – Earthwork.

3.4 Balling, Burlapping, Transporting

- A. Dig plants in a manner to retain as many fibrous roots as possible. Spray with anti-desiccant at Nursery before moving, in strict accordance with manufacturer's recommendations. Apply as required with spray equipment over trunks, branches, twigs and foliage.
- B. Balled and burlapped plants shall have balls of earth of sufficient diameter to be in accordance with the size of the plant, of sufficient depth to include an adequate root system, and shall be properly balled, burlapped, and secured. Plants with mushy, badly cracked or frozen earth balls will not be acceptable.
- C. Prevent injury to plant material when digging, moving, transporting, unloading and planting.
- D. Protect plants from the wind by wrapping with tarpaulins during transport.

3.4 LAYOUT, EXCAVATION, PREPARATION OF TREE PITS AND PLANT BEDS

- A. All tree pits and plant beds shall be located as shown in Contract Drawings and shall be properly excavated and prepared for planting in accordance with the type of plant material in each location, as indicated in 3.6 of this Section.

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B. Tree pits:

1. Rootball to be placed on undisturbed sub grade. Tree pits surrounding the perimeter of the rootball shall be excavated four-inches (4") deeper than the depth of the tree root ball at undisturbed grade. All construction debris such as plaster, concrete, stone, brick and wood shall be removed.
2. All tree pits shall be excavated circular with sloped sides. Diameter of pits for trees shall be at least 2.5x the diameter of the ball. If an impervious, hardpan layer remains in the bottom of the pit after excavation, the pit shall be excavated to a depth of the hardpan or 36 inches below the bottom of the ball. Pit shall then receive a 6-inch layer of AASHTO 57 stone, covered with straw, roofing paper, or similar material prior to installation of tree.

C. Planting Beds

1. All shrubs, groundcovers and perennials shall be installed in continuous plant beds excavated in accordance with the planting details and to minimum depths as indicated in 3.6 of Section 329113 – Planting Preparation.

D. Exercise extreme caution during excavation to avoid damaging or interrupting existing underground utilities. Use appropriate detection equipment to locate utilities during excavation of pits to the required depth. Perform excavation work near utilities by hand.

E. Erect barricades, warning signs, or other protective devices as is required by local, State, or Federal laws and regulations to protect open excavation.

F. Obstruction Below Ground

1. In the event that rock, underground construction work, utilities, or obstructions are encountered in any plant pit excavation work under this contract, an alternate location may be selected by Sikora Wells Appel.
2. Where locations cannot be changed, the obstruction shall be removed, to a depth of not less than three (3) feet below grade and no less than six (6) inches below bottom of ball or roots when plant is properly set at the required grade. Payment shall be made in accordance with the contract.

G. Inspect tree pits and planting beds to assure that adequate drainage exists. In instances of poor drainage, advise the Design Professional and await instructions before planting.

H. Scarify bottom and sides of tree pits and planting beds prior to placing plant material. Place a layer of planting soil mix and tamp to prevent settlement.

3.5 INSTALLATION OF PLANT MATERIAL

A. Prior to planting, trees shall be inspected by Sikora Wells Appel for injury to trunks, evidence of insect infestation, or improper pruning.

B. Placement of Plants

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1. Plants shall be spaced and set plumb and straight, in accordance with the planting plan and details, and faced to give best appearance and relationship to adjacent plants and structures. Trees shall be centered in all tree pits.
2. Plants shall be set to such a depth that the finished grade level, after settlement, will be the same as that at which the plant was grown and so that the root flair is at finished grade.
3. All ropes, staves and other bindings shall be cut off the tops and sides of balled and burlapped (B&B) plants and removed from plant pits/beds. Do not pull burlap out from under balls. All rot-proof, rot-resistant, plastic burlap and top half of wire basket (minimum) ball coverings shall be removed prior to planting. Cleanly cut off all broken or frayed roots.
4. Remove plants from containers by cutting or inverting the container.

C. Backfilling

1. Use planting soil mix as specified in Section 329113 – Planting Preparation for all backfilling around plant earth balls and roots.
2. Compact planting soil mix around base of balls and roots of plants to fill all voids. Ensure at this point that all burlap and ropes have been removed from tops of root balls and that all non-biodegradable materials have been removed from plant pits/beds. Clip and fold down wire baskets.
3. Backfill the planting soil mix in layers of not more than six-inches (6"). Thoroughly compact each layer to not greater than 85%, in order to eliminate all voids, before placing the next layer.
4. Continue adding and tamping soil until the planting pit/bed is half full. Add water to partially fill planted area. Let the water soak into the soil and finish backfilling. Place final layer of loose planting soil mix without further packing.
5. Secure trees smaller than 5-inch caliper immediately after planting with methods shown on the Landscape Details sheet. Provide a minimum of 3 guys per tree secured using anchors. Trees shall stand plumb after staking.
6. Contractor shall be responsible for removing stakes, rubber hose, and guys at the end of the warranty period.

3.6 MULCHING

- A. Provide mulching for all plant beds and tree pits within 48 hours after planting.
- B. Mulch all plant beds with a 3-inch (3") layer of shredded bark. It shall entirely cover the area of the plant bed. Do not mulch next to the main stem of plant.
- C. Groundcover and perennial areas shall be mulched prior to planting.
- D. Mulch tree pits, where noted on Contract Drawings and in accordance with planting details, with 3-inches (3") of double shredded hardwood mulch.
- E. Mulch material shall not come in contact with the trunk of trees and shrubs. Keep approximately 3" away from all sides.

3.7 PRUNING

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- A. Neatly prune plant materials to preserve the natural character of the plants and in a manner appropriate to the particular requirements of each plant. Prune plants after installation.
- B. Remove broken or badly bruised branches with a clean cut. In general, remove at least one-fourth of the wood of deciduous plants by thinning of branches. Remove any dead branches by cutting flush with trunk or main limb.
- C. Do all pruning with clean sharp tools.

3.8 CARE OF SITE

- A. Landscape Contractor shall be responsible for the maintenance of any and all existing or proposed lawn or turf areas for the duration of the project. Any existing lawn or turf shall be mowed on a periodic basis following industry maintenance standards and practices.
- B. The proper care of planting areas, adjacent pavement, and existing plants shall rest with the Landscape Contractor during the progress of all Work. The Landscape Contractor shall confine planting soil mix, materials, and equipment to such limits that will not interfere with normal pedestrian and vehicular traffic, and all walks and pavement shall be kept clean at all times except when unavoidable in the actual performance of the Work.
- C. Maintenance: The Landscape Contractor shall be responsible to provide the following maintenance on all newly planted vegetation during the one-year guarantee period:
 - 1. Watering--During periods of inadequate rainfall, all plant material shall be watered to maintain a constant suitable moisture level for adequate plant growth. Landscape Contractor shall be responsible for providing water hoses, sprinklers, and automatic timers. The Department will supply the water source.
 - 2. Weeding – Weed control shall be by hand or mechanical means. Herbicide use is acceptable with the Department approval. Under no circumstance shall pre-emergent herbicides be used on-site. Site shall be weed free when turned over to the Department.
 - 3. Insect, disease, and weed control--No spraying of herbicides, insecticides, fungicides, nematicides, fumigants or other chemicals shall be done without first submitting a spray program to the Department for approval. After approval, application will only be permitted by licensed applicators. Applicators shall follow Notification Requirements and consult any Chemical Hypersensitivity Registries for the area.
 - 4. Contractor to protect plants from wildlife damage during warranty and establishment period.

3.9 Semi-Final Observation

- A. Review of the Work to determine its completion for beginning the guarantee period will be made by the Department and Design Professional upon written notice requesting such inspection submitted by the Landscape Contractor at least ten days prior to the anticipated date.
- B. All plants shall be healthy and thriving at the time of semifinal observation.

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- C. After review, the Landscape Contractor will be notified of the date that the Work has been approved for beginning the guarantee period or, if there are any deficiencies, of the requirements for beginning this period.

3.10 Guarantee and Maintenance

- A. Guarantee. Plants shall be guaranteed for one (1) year after planting and shall be alive and in satisfactory growth at the end of the guarantee period. Plants which die within the guarantee period shall be removed by the Landscape Contractor within ten (10) days of notice or the Department will remove the plants and bill the Landscape Contractor accordingly. All reasonable efforts shall be made to replace plants within the period listed above following notification from the Department. All replacements shall be plants of the same kind and size as specified in the plant list. They shall be furnished and planted as specified under planting; the cost shall be borne by the Landscape Contractor, except for possible replacements resulting from removal, loss or damage due to vandalism, or act of neglect on the part of others.
- B. Guarantee deciduous trees and coniferous trees for two years from date of acceptance.
- C. The Department's grounds maintenance crew will begin care and maintenance of the plant material after date of acceptance.
- D. Contractor's maintenance shall include watering, cultivating, weeding, mulching, control of insects and diseases; control of deer and geese damage; pruning, and other horticultural operations for proper growth and appearance of plant materials and beds, including fertilizing if required.
- E. Guarantee that plants will be in a vigorous and thriving condition at the end of the guarantee period. Shall any plants (excluding plants previously replaced during guarantee and maintenance period) appear to be in poor health or lack normal growth habit, remove them at once and replace in a manner as hereinbefore specified.

3.11 Exclusions From Guarantee

- A. During the Guarantee period, damage to planting not caused by the Landscape Contractor, shall be excluded from the Guarantee.
- B. Such damage shall include damage by vehicles, theft, fire, or acts of vandalism.
- C. Where evidence of such damage exists, advise the Department in writing, stating nature and location of the damage. The Department, upon receipt of such notice, may order the Landscape Contractor to correct the damage at the Department's expense, or exclude the damaged work from the Guarantee provisions and correct the damage by any arrangement deemed by the Department in his best interest.

3.12 Final Observation

- A. Final Inspection and Acceptance:
 - 1. At the end of the guarantee period, inspection will be made by the Department and the Landscape Contractor. Any plant required under this contract that is dead or not in

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satisfactory growth, as determined by the Department, shall be removed from the site and replaced at the Landscape Contractor's expense. These plants shall be replaced as soon as conditions permit, but during the normal planting season.

END OF SECTION

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SECTION 32 94 00 SEEDING AND GROUNDCOVERS

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

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

1.3 SUMMARY

- A. Section Includes:
 - 1. Seed Bed Preparation.
- B. Related Sections:
 - 1. Section 329113 Planting Preparation
 - 2. Section 329300 Plants
 - 3. Section 329200 Turf & Grasses

1.4 DEFINITIONS

- A. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.
- B. Finish Grade: Elevation of finished surface of planting soil.
- C. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
- D. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- E. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

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- F. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- G. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
- H. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.5 SUBMITTALS

- A. Provide a list of Nurseries/ Seed Suppliers from which each type of plant material for this project is coming from.
- B. Product Data: For each type of product indicated.
 - 1. Pesticides and Herbicides: Include product label and manufacturer's application instructions specific to this Project.
 - 2. Rotary Decompactor: EARTHQUAKE or approved equal.
- C. 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.
- D. Qualification Data: For qualified landscape Installer.
- E. Product Certificates: For soil amendments and fertilizers, from manufacturer.
- F. Material Test Reports: For imported or manufactured topsoil. Samples shall be grouped by planting type at a frequency of no less than 1 per half acre.
- G. Maintenance Instructions: Recommended procedures to be established by the Department for maintenance of meadows during a calendar year. Submit before expiration of required initial maintenance periods.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful fine lawn seeding.
 - 1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network, the American Nursery and Landscape Association, or an approved equivalent.
 - 2. Experience: Five years' experience on projects of a similar scope and size.
 - 3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.

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4. Pesticide Applicator: State licensed, commercial.

- B. Pre-installation Conference: Conduct conference at Project site prior to planting each ecotype that includes a site visit with proposed locations and distribution of mixes.
- C. Prepare sample planting areas for review and approval by the Department:

1.7 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 conformance with state and federal laws, as applicable.
- B. Store seed in a manner that ensures against rot, predation by rodents, pre-germination, or other factors that lead to seed inviability.
- 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 fertilizers, lime, and soil amendments with appropriate certificates.

1.8 PROJECT CONDITIONS

- A. Planting Restrictions: Plant seed during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of Substantial Completion.
 - 1. Spring Planting: April 1 to June 15.
 - 2. Fall Planting: September 1 to November 15.
- B. 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.

1.9 GUARANTEE

- A. In addition to the specific guarantee requirements of the General Conditions and Supplementary General Conditions, the Contractor shall obtain in the School District's name the standard written manufacturer's guarantee of all materials furnished under this Section where such guarantees are offered in the manufacturer's published product data. All these guarantees shall be in addition to, and not in lieu of, other liabilities, which the Contractor may have by law or other provisions of the Contract Documents.

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PART 2 - PRODUCTS

2.1 SEED MIX

- A. LESCO Tall Fescue Select Blend (Certified)
 - 1. Endophyte-enhanced.
 - 2. Blue Tag Certified.
- B. Seeding Rate
 - 1. New establishment: 6-8 lb. per 1,000 sq. ft.
 - 2. Overseeding: 5-7 lb. per 1,000 sq. ft.

2.2 ORGANIC SOIL AMENDMENTS

- A. Composted Leaf Mulch: Well-decomposed, stable, and weed-free organic matter, pH range of 6.0 to 7.5; moisture content 30 to 60 percent by weight; 100 percent passing through a 1-inch sieve; maximum soluble salt content of 3.5 dS/m; not exceeding 1.0 percent inert contaminants and free of substances toxic to plantings; and as follows:
 - 1. Organic Matter Content: 50 to 80 percent of dry weight.
 - 2. To be derived from a variety of leaf and yard trimmings or tree wood with no objectionable odors or substances toxic to plants. Material aerobically composted at a DEP, Bureau of Waste Management permitted site and conforming to CFR 503. Test in accordance with U.S. Composting Council's Test Methods for Examining of Composting and Compost (TMECC). Provide compost with the U.S. Composting Council's Seal of Testing Assurance Program (STA) certification and STA product label.

2.3 PLANTING SOILS

- A. Topsoil - On-site topsoil or topsoil acquired from off-site, plus required additives. Topsoil shall be acquired in accordance with all applicable federal, state, and local regulations.
- B. Only if on-site topsoil is insufficient in quantity to provide specified thickness in areas shown, provide additional topsoil from approved off-site sources as required to complete the Work. Off-site topsoil shall meet the following minimum requirements:
 - 1. See Planting Preparation Spec for the mixture and testing requirements for the soil in specified planting beds.
 - 2. When topsoil from off-site sources is required, have this soil tested and submit samples as described in this section under 1.4 and 1.5.
 - 3. If needed to achieve final grade, on-site topsoil may be used only if it meets the requirements of this specification. On-site topsoil shall be screened on-site, prior to spreading, to remove all lumps, roots, and debris greater than 1 inch diameter and not contain toxic substances harmful to plant growth.
 - 4. Unscreened topsoil shall be guaranteed to be free of debris and foreign matter and shall meet the requirements of this section.
 - 5. The samples of topsoil shall be submitted by the Landscape Trade Contractor to a private testing laboratory for testing and analysis. No topsoil shall be used until test results have

been received and approved by the Department and any and all amendments have been made.

6. Nutrient Analysis: Have nutrient levels (nitrate, nitrogen, phosphorous, potassium, magnesium, calcium, etc.) tested and request testing laboratory recommendations for fertilizer requirements for lawn areas and planting areas if nutrient levels are below average.
7. Unamended topsoils rarely meet the requirements for "planting soils" that are best for plant growth. Consult soil experts or testing laboratory on how to modify and fertilize topsoil types to obtain acceptable planting soils for site conditions and each plant species. See Evaluations.

2.4 PESTICIDES

- A. General: Pesticide registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- C. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to be planted for compliance with requirements and other conditions affecting performance.
 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. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
 3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
 4. Uniformly moisten excessively dry soil that is not workable and which is too 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 Stantec and replace with new planting soil.

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3.2 SEEDING

- A. Sow seed with Truax Drill Seeding Machine. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
 - 1. Do not use wet seed or seed that is moldy or otherwise damaged.
 - 2. Seeding shall be completed before installation of Trees.
- B. Stabilize newly seeded areas with mulching material as recommended by seed producer.
- C. Water newly planted areas and keep moist until meadow is established.

3.3 PESTICIDE APPLICATION

- A. Apply pesticides and other chemical products and biological control agents in accordance with requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with the School District's operations and others in proximity to the Work. Notify the School District before each application is performed.
- B. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.4 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by Seeding work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. 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.
- C. Remove non-degradable erosion-control measures after Seed establishment period.

END OF SECTION