FAIRVIEW CAMPUS

New Middle School and High School

Tony Marchio Drive
Townsend, DE 19734

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BID PAC 'C-D'

CONFORMANCE SET

REBID

Volume 3 of 3
DIVISIONS 21 - 34
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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 and dry-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, low air 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 21 Section “Fire Pump”
3. Division 22 Section “General Provisions – Plumbing/Fire Protection
4. Division 10 Section “Fire Protection Specialties” for cabinets and fire extinguishers.
5. 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 it's 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/the connection to the City water main/the fire pump discharge, 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 7/15/17 and data is recorded on the drawing.

D. Sprinkler and Stnadpipe 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 ¼” 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.
9. Fire Hose Valve Cabinets:
   Potter-Roemer
   Larsen
   Guardian Fire Equipment, Inc.
   Fire-End and Croker Corp.
10. Fire-Protection-Service Valves:
    Tyco Fire Suppression & Building Products
    Central Sprinkler Corp.
    Nibco, Inc.
    Stockham Valves & Fittings, Inc.
    Victaulic Company
11. Keyed Couplings for Steel Piping: (Grooved Fittings)
    Tyco Fire Suppression & Building Products
    Victaulic Company
    Viking Corp.
    Anvil International Grulok
12. Fire Protection Backflow Prevention Valve Assemblies (including RPZ Type).
    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. "THINWALL/SCHEDULE 10," "XL" AND CPVC 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 (Flush, recessed and/or concealed)

Quick-response sprinklers

Sidewall sprinklers

Upright sprinklers

E. Sprinkler Finishes: Upright bronze, and “white” painted pendents 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 air Supervisory Switch: UL listed, electrical-supervisory-type, pressure activated, single pole, double throw, normally closed contacts, field adjustable and designed to operate on a decrease in air pressure.

G. 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.

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. Where used, antifreeze systems shall use pharmaceutically pure glycerin or propylene glycol only and shall be premixed in accordance with NFPA 13. Provide a reduced pressure zone backflow preventer assembly and an expansion chamber where noted on the drawings, at the point of connection to the wet sprinkler system supply. Pipe discharge port of backflow preventer to a drain point capable of accepting full flow discharge. Antifreeze systems over 40 gallons total capacity shall be hydraulically calculated using the Darcy-Weisback equation, Moody Diagram, E-factors for age of pipe, and adjusted K-factors for fluid properties.

L. Provide standpipe system hose connections at all locations as required by NFPA #14, the Delaware State Fire Prevention Regulations, the Authority having Jurisdiction and thoughs 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 Drawing FP-2.

D. Wet-Pipe Sprinkler Branch and Standpipe Piping: See Fire Protection Drawing FP-2.

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 Drawing FP-2.

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.

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: 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. Fill antifreeze system with proper antifreeze/water mixture and verify mixture after fill.

H. Adjust operating controls and pressure settings.

I. Coordinate with fire alarm tests. Operate alarm devices with water, as required to demonstrate proper function.

J. Provide a flow test for record on the site fire hydrants nearest the building regardless of the previous date. Data to be included below.

K. 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.
2. Completed and signed "Contractor's Material and Test Certificate for Underground Piping."

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 & strapes 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 21 0170

SECTION 21 0171
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 58 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
   Firetrol
   Tornatech
   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. Main relief valve (optional for electric)
13. Circulation relief valve
14. Relief cone – enclosed (optional for electric)
15. Automatic air release valve
16. Splash shield (electric drive only)
17. Balldrip valve
18. 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, across-the-line type, 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 - across-the-line 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 120 p.s.i.g. and out at 130 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 umpellers 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 ¾ HP, 3 phase, 460 volt ODP enclosure using a rigid split coupling. Moptor bearings shall be sized to alow 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 ne essary circuitry to prodive 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 21 0171

SECTION 22 0000

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.

D. Refer to Section 07841 for Through-Penetration Firestop Systems.

E. Refer to Section 08311 for Access Doors and Frames

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. 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.

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 the 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 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.

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. 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. Provide to the Owner any special tools necessary for operation and routine maintenance of any of the equipment.

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. 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

Material	Horizontal Max. Feet	Vertical Max. Feet
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 be10’-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. Fire stopping of all thru-penetrations of fire and/or smoke rated assemblies (partitions, floors, ceilings, etc.) shall be the responsibility of each installer or building trade (Mechanical, Plumbing, Electrical, Communications, Data, etc.) making the thru-penetrations, unless otherwise indicated on the Architectural series drawings (A-series). It is the responsibility of the Contractor making the thru-penetrations to verify and coordinate fire stopping with fire rating, assembly type and field conditions.
2. 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.
3. Products: Refer to Division 7 of the specifications for Fire Stopping Requirements.

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 a minimum 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 22 0000

SECTION 22 0010
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:

New Castle County Department of License and Inspection

New Castle County Department of Sewers

Delaware State 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

2.1 STEEL PIPE & FITTINGS

A. Pipe: ASTM A-53, seamless, Schedule 40.

B. Fittings:

1. Cast iron, threaded, 175 psi, ANSI B-16.4.
2. Malleable iron, threaded, ASA B 16.3.
3. Steel, socket weld, ASTM A-53.
4. Wrought iron, socket weld, ASTM A-72.

C. Thread tape shall be teflon tape, 3 mils minimum thickness. Teflon tape shall not be permitted for use on gas piping systems.

D. See Section 220130 for Gas Piping Systems.

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-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 extra heavy schedule 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 POROUS CONCRETE PIPE

A. Pipe & Fittings: Porous concrete drain pipe, A.A.H.O. designation M176.

B. Joints: Interlocking tongue and groove.

2.8 REINFORCED CONCRETE PIPE AND FITTINGS

A. Pipe & Fittings: Reinforced concrete, ANSI/ASTM C-75, Class 2.

B. Joints: Modified tongue and groove, with compression gasket, ANSI/ASTM C-443.

2.9 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

2.10 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.

2.11 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.

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 (Viega or Nibco only)

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.

2.12 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.

2.13 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.

2.14 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.

2.15 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.

2.16 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.

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. This project includes a return air plenum ceiling. Regardless of materials specified, all system piping and/or materials shall be non-combustible and shall be in full compliance with the requirements set forth in the IPC.

G. 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.

H. Do not install trapped lines where water cannot be drained or air can accumulate without being vented.

I. Piping shall run square with building lines.

J. Piping shall not be insulated or covered until tested and until building is closed in.

K. Necessary drains, off-sets, vents and drips shall be provided for coordination of the work as part of the contract.

L. 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.

M. Allow clearance for expansion and contraction.

N. Install isolating fittings between sections of ferrous and non- ferrous pipe or connected equipment.

O. Valves shall be installed with stems above horizontal.

P. Valves shall be installed on all sides of equipment and control valves to allow isolation for repair.

Q. 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.

R. 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.

S. Unions shall be provided adjacent to all valves, at equipment connections, and where necessary to facilitate dismantling of the piping system.

T. 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.

U. 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.

V. 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.

W. All pipe unions installed shall be accessible. Unions shall not be concealed or located in places where they cannot be maintained.

X. Support and bracing of 4" and above pipe shall be in accordance with the CISPI Standards and IPC Chapter 3.

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. 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 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 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. 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.

E. 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

F. Lead-Tin (50-50) solder or any solder containing lead shall NOT be used or permitted for joint connections on this project.

G. 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.

H. Form continuous solder bead or brazing filler bead around entire circumference of joint.

I. Wipe excess solder from joint area while solder is still plastic.

J. 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 or Nibco copper press fitting system only. 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 ProPress 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 ProPress copper press joint systems. ProPress 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 or Nibco Press-RT 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 ProPress 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 22 0010

SECTION 22 0030
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. 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 150ºF.
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. All electrical heat tracing installations shall be coordinated with the electrical contractor. No insulation shall be installed until the heat trace wiring is completely installed, tested and approved. All insulation materials and installation work shall be the responsibility of the Insulation Contractor.

I. 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.

J. Insulation shall be pushed onto the pipe, never pulled. Stretching of insulation may result in open seams and joints.

K. Tape the ends of the copper tubing before slipping the Armaflex insulation over the new pipes to prevent dust from entering the pipe.

L. 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.

M. 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.

N. 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.

O. 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 o 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 OUTDOORS EXPOSED PIPING

A. All outdoor exposed piping shall be painted with two coats of WB Armaflex Finish. Prior to applying the Finish, the insulation shall be wiped clean with denatured alcohol. The Finish shall not be tinted.

B. All outdoor exposed piping shall have the seams located on the lower half of the pipe.

3.5 EXTERIOR PIPE COVERING

A. Wrapping: Wrap insulation with embossed .016" aluminum jacket.

B. Fastenings: Cover shall be held in place with soft aluminum bands on 12" centers.

C. Valves and Fittings: Weatherproof all valves and fittings.

D. Finish: Apply two coats of vapor resistant mastic reinforced with glass fabric over wrapping.

3.6 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.

3.7 PIPE INSULATION – TYPES & THICKNESSES

A. Flexible Closed Cell:

Piping System	Up to 3"	Over 3" to 6"	Over 6"

Cold Water	½”	½”	¾”
Hot Water (120º)	1”	1”	1-1/2”
Hot Water Return (120º)	1”	1”	1-1/2”
Hot Water (140º)	1”	1”	1-1/2”
Hot Water Return (140º)	1”	1”	1-1/2”
Condensate Waste	½”	½”	-
Horizontal Storm (Primary)	½”	½”	¾”
Horizontal Storm (Secondary)	-----Not Required-----		
Underside of Roof Drains	½”	½”	¾”
Branch Waste From EWC’s	½”	---	---
Soil/Waste Piping Above Ceiling (where noted)	½”	½”	¾”

B. Fiberglass:

Piping System	Up to 3”	Over 3” to 6”	Over 6”
Cold Water	½”	½”	¾”
Hot Water	1”	1”	1-1/2”
Hot Water Return	1”	1”	1-1/2”
Hot Water	1”	1”	1-1/2”
Hot Water Return	1”	1”	1-1/2”
Condensate Waste	½”	½”	---
Horizontal Storm (Primary)	½”	½”	¾”
Horizontal Storm (Secondary)	-----Not Required-----		
Underside of Roof Drains	½”	½”	---
Soil/Waste Piping Above Ceiling (when noted)	½”	½”	¾”

END OF SECTION 22 0030

SECTION 22 0110
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 <u>all</u> 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 an option selection of a, b, or c below:
   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.

2.3 CONDENSATE WASTE PIPING SYSTEM

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

1. Copper tubing, type DWV with wrought copper solder type drainage fittings.

2.4 ACID WASTE PIPING

A. Pipe & Fittings: Polyvinyllidene fluoride (PVDF), ASTM F-1673, pipe shall be marked with “UL” to indicate compliance with UL723 (ASTM E84).

B. Joints (Aboveground)

1. No hub, plain end, outerban, nuts and bolts per ASTM B117.

2. Socket Fusion: ASTM 2657, ASTM D3222.

C. All above ground acid waste piping including connections to lab sink or equipment shall be:

1. Flame retardant polypropylene Type II Schedule (40) (80), with mechanical or fusion-welded joints.
2. Schedule 40 Borosilicate glass pipe and fittings with stainless steel couplings.

2.5 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.

2.6 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.

2.7 BACKWATER VALVES / FLOODGATE

A. Backwater valves (BWV) installed in the interior or exterior building sewer extension, shall be all PVC construction materials.

B. The backwater valve shall be in compliance with the latest edition of IPC and UPC Plumbing Codes.

C. Description:

1. The BWV shall be as manufactured in accordance with “ICC-ES” criteria.
2. The BWV shall be 3- and 4-inch diameter backwater valves, shall meet the performance requirements of CSA B181.1 and CSA B181.2. The factory kit consists of a valve body, disc, disc seat, and upper collar. The factory supplied plastic materials conform to NSF 14-99 and ASME A 112.14.1.
3. Removal of the integral lifting device from a buried valve allows above-grade replacement of the disc assembly and reinstallation into the valve body. The integral lifting device is self-aligning, self-seating, and provided with an alignment indicator located within 12 inches (305 mm) of the upper access opening.
4. <u>Floodgate / Backwater Valve Basin</u>

   Valve basin must be installed in a ventilated and dry access pit in the horizontal drain line between the building and the sewer main.

   Provide access pit of a size that will provide suitable room to inspect and or replace the valve.

   Floodgate / backwater valves are approved for storm and sanitary drain systems. Consult with the local plumbing and sewer authority for any additional requirements.

2.8 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

J.R. Smith

MIFAB

Roof Drains

Froet

Zurn

Josam

Wade

Watts

J.R. Smith

MIFAB

Cleanouts

Zurn

Josam

Wade

Watts

J.R. Smith

MIFAB

Interceptors

Zurn

Josam

Wade

Watts

Smith

Woodford

MIFAB

Backwater Valves & Traps (Cast Iron)

Zurn

Josam

Wade

Watts

Smith

Red Valve Co.

MIFAB

Backwater Valve (PVC)

Clean Check, Inc.

Wall Spout (Downspout) Nozzles

Froet

Zurn

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 3" and smaller, and 1/8" per foot (1%) for piping 4" 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.

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.

3.3 INSTALLATION OF ACID WASTE & VENT PIPING

A. Connect to all laboratory equipment requiring acid waste piping, furnish and install traps and extend piping to sanitary drainage piping as indicated.

B. Acid vents shall be extended through the roof, independently of the sanitary system vents.

C. All acid resistant pipe shall be installed in strict accordance with the manufacturers recommendations. The use of solvent cement to dissimilar PVC pipe materials shall not be permitted.

D. All changes in direction of acid 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.

E. 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.

F. Install acid waste and vent piping pitched to drain at minimum slope of 1/4" per foot (2%) for piping 3" and smaller, and 1/8" per foot (1%) for piping 4" and larger.

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 floor drains shall be provided with trap primer connections. All floor drains shall have a trap primer discharge line connected to the outlet.

F. 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 BACKWATER VALVES

A. A threaded plug, female adaptor and 6-inch diameter (152.4 mm) pipe shall be supplied by others for use as the access sleeve and cover. The access sleeve shall be cut to length in the field and attached to the socket on the top of the valve body. This forms the housing for the removable integral lifting device. The integral lifting device consists, in part, of a 4-inch diameter (101.6 mm) pipe which is supplied by others. The 4-inch diameter (101.6 mm) pipe is cut to length in the field, then joined to the disc assembly on the bottom and the collar on the top.

B. The manufacturer’s published installation instructions shall be strictly adhered to and, if requested by the code official, a copy shall be maintained on the job site during installation. A copy of the maintenance instructions shall be left with the Owner.

3.9 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.

3.10 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.

3.11 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.

3.12 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.

3.13 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.

3.14 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 22 0110

SECTION 22 0120
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 main at curb to building domestic water piping.
2. Exterior water service piping from connection 5'-0" beyond building foundation to building domestic water piping.
3. Exterior fire/sprinkler service from connection 5'-0" beyond building foundation to flanged connection 12" above finished floor slab in Fire Pump Room.
4. Domestic cold-water piping.
5. Domestic hot-water piping.
6. 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.

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. <u>Sectional Valves:</u>

2-1/2" and Smaller:	Ball Valves.
	Gate Valves.
3” and Larger:	Ball Valves.
	Butterfly Valves.

C. <u>Shutoff Valves:</u>

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: Provide roughing- in and bypass for meter in accordance with code 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.

D. Lawn Boxes: Non-freeze, bronze ground hydrant with locking cover, rough bronze box, vacuum breaker, 1 inch connection, and suitable for 4'-0" depth of bury.

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, blackflow 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:

<u>Shock Absorbers:</u>

Zurn

Josam

Wade

Watts

Smith

PPP Inc.

MIFAB

<u>Wall Hydrants</u>

Zurn

Josam

Wade

Watts

Smith

Woodford

MIFAB

<u>Lawn Boxes</u>

Zurn

Josam

Wade

Watts

Smith

Woodford

MIFAB

<u>Backflow Preventers</u>

Conbraco

Febco

Cla-Val

Wilkins

ITT Grinnell

Neptune

Watts

<u>Relief Valves</u>

Rockwell

Fisher

DeZurik

Pressure Reducing Valves

Conbraco

Jamesbury

DeZurik

Fisher

ITT Bell & Gossett

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.

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.

3.3 INSTALLATION OF DOMESTIC WATER SERVICE SYSTEM - SITE

A. Install site water service system in compliance with local governing regulations.

B. Water Service Piping: Extend water service piping from site connection and from the meter pit to the water service entrance at building. Provide sleeve in foundation wall for water service entry; make entry watertight. Provide gate valve at water service entry inside building; strainer, pressure gauge, test tee with valve.

C. Ductile-Iron Pipe: Install in accordance with ANSI/AWWA C-60.

D. Sterilization: At completion of water service line installation, flush and sterilize in conformance with AWWA C-601, to satisfaction of local Authorities having jurisdiction.

3.4 INSTALLATION OF PIPING SPECIALTIES

A. Install piping specialties in accordance with Section 220010 Basic Materials and Methods.

B. Water Hammer Arresters: Install in upright position, in locations and of sizes in accordance with PDI Standard WH-201, and elsewhere as indicated.

3.5 INSTALLATION OF LAWN BOXES

A. Lawn boxes shall be provided with 18" x 18" x 6" concrete pad at grade, unless located in paving. Installation shall include 1 cu. ft. of crushed stone at the base of the hydrant, to accept drainage from weep holes.

3.6 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.

3.7 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.

3.8 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.

3.9 INSTALLATION OF PRESSURE REGULATING VALVES

A. Install pressure regulating valves where indicated. Provide inlet and outlet shutoff valves, and ball valve bypass. Provide pressure gauge on valve outlet.

3.10 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

3.11 INSTALLATION OF THERMOMETERS AND GAUGES

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

3.12 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 manufacturer.

3.13 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.

3.14 SPARE PARTS

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

3.15 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.

3.16 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.

3.17 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 22 0120

SECTION 22 0130
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. Elevated pressure (psi) gas from meter location to rooftop gas-fired equipment and to all other equipment and outlets, requiring gas service.

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 (Low Press), Wrought steel, butt welded (Medium/High pressure).

2. Exterior Below Grade Piping: Medium-density polyethylene pipe and fittings by reference meet the Department of Transportation Title 49 Part 192.

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

   Fittings: Wrought steel, butt welded (medium/high pressure), malleable black iron, threaded (low pressure)

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:

<u>Gas Valves: (Up to 3”)</u>

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.

<u>Gas Valves (4” and Larger)</u>

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 Delmarva Power 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 manufactured by Fisher (no equal substitute permitted).

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.

   NOTE: All interior medium/high pressure gas piping shall be Schedule 40 black steel with welded joints.

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 5 psi to 7-14" 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.

OR

C. In lieu of coated steel pipe, the Contractor may use high grade material, physical and mechanical properties as classified in accordance to ASTM D 3350 and cell classification of 234373E plastic pipe and fittings for underground use only, and shall conform with ASTM D-2513. Pipe shall be marked "GAS" and "ASTM D-2513". Only Contractors registered and/or certified for installation of underground or below-grade plastic piping shall be permitted to install this material on this project.

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.

OR

A. All exterior gas pipe and fittings installed, including all welded joints, shall be provided with weatherproof coatings. The coatings shall be a two-layer PE "Pritec" coating as manufactured by Liberty Coating. The coatings shall be Butyl rubber adhesive with a polyethylene topcoat.

B. Component Properties:

Adhesive

Polyethylene

ADHESIVE		
Softening Point	ASTM E28	190°F
Water Absorption	ASTM D570	<0.1%
Adhesive		Compounded Butyl Rubber

POLYETHYLENE		
Color		Black
Density	ASTM D1505	>0.950
Elongation	ASTM D638	>600%
Tensile Strength	ASTM D638	>2,800 psi
Outdoor Exposure		>2 years
Hardness, Shore D	ASTM D2240	>60

PRITEC®		
Operating Temperature		-40°F to +180°F
*Peel Strength	ASTM D1000	>20 lbs lineal
Field Bending	Arctic Service Equipment	1.9 deg. per pipe dia.
Water Absorption	ASTM D570	0.06%
Impact Resistance	ASTM G14	33.65 in/lbs (10/40 sys.)
Volume Resistivity	ASTM D257	$10x10^{16}$ Ohm cm
Dielectric Strength	ASTM D149 @73°F	700 Volts/Mil
Cathodic Disbondment	1.5v/3%/70°F/24 Hrs.	6 mm radiius

END OF SECTION 22 0130

SECTION 22 0140
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

   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-11with 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 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

Toto

<u>China/Enameled Fixtures</u>

Zurn

Kohler

American Standard
ToTo
Wash Fountains
Acorn with metered faucets (only)
Faucets/Trim (Non-Sensor Operated)
Zurn
Kohler
American Standard
Delta
Moen
Elkay
Speakman
Chicago
Flush Valves
Sloan "Royal"
Coyne & Delany
Zurn
ToTo
Wall Supplies/Traps
McGuire
Brass-Craft
Kohler
American Standard
Sanitary-Dash
Teledyne
Wolverine
Pro-Flo
Keeny
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
Emergency/Safety Equipment
Bradley
Haws
Western
Speakman
Guardian
Shower Units
Fiat
Fibersheen

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

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.

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.

C. Protective shield enclosures are required on the toilet room's countertop lavatories and are furnished by the Architect. Coordinate all trim and accessories to fit within this enclosure.

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 22 0140

SECTION 22 0150
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:

   Packaged 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 of 5 gallons per minute against a total discharge head of 17 feet.

B. Pumps shall be close coupled, centrifugal type, all low lead or lead free bronze with flexible connection to a 1/6 HP, 1750 RPM, 60 cycle, 120 volt, 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. Water heaters shall be Bradford White Model, as noted on the drawing schedule, with a storage capacity as noted on the drawing schedule, a minimum input natural gas BtuH rating or electrical KW rating as noted on the drawing schedule, and a minimum recovery as noted on the drawing 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 traffic/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
   PVI
2. Hot Water Circulating Pumps
   Armstrong
   Bell and Gossett
   Taco
   Aurora
   Grundfos
   Amtrol
3. Solids Interceptors
   Zurn
   Josam
   Wade
   Ancon
   Smith
4. Exterior Interceptor
   Gillespe
   Highland Tank
   Tyson F. Sartin
   A.C. Miller
   Penn Cast
5. Master Mixing Valve (Domestic Hot Water System)
   Acron
   Holby Valve Co.

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 20º 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 22 0150

SECTION 22 0190
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. Domestic 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 piping at a minimum pressure of 125 psig maintaining the pressure for two hours without more than 2% drop in pressure. The system shall be filled with water which shall remain in the system until the water and piping are the same temperature.

OR

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

Arc Company, Inc.

Nova Consultants

Artesian Water Co.

END OF SECTION 22 0190

SECTION 22 0191
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 22 0191

SECTION 23 0200
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: 23 0200 thru 23 0950.

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 indentify 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 SITE INSPECTION

A. The Contractor shall visit site, inspect, and become aware of all conditions which may effect the work during the estimation phase of his work 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 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.

1.10 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.

1.11 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.

1.12 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.

1.13 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.

1.14 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 under any equipment 10 HP and over and rubber in shear vibration isolation on any equipment up to 10 HP. 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.

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.

J. Piping on the roof shall be supported by an engineered, prefabricated hanger system specifically designed for installation on the roof without roof penetrations, flashing or damage to the roofing material. The system shall consist of bases made of high density polypropylene plastic with additives for UV protection, hot dipped galvanized structural steel frames, hangers, fasteners, rods, etc. The system shall be complete and designed to fit the piping installed under actual conditions of service. The system shall be furnished as manufactured by PHP Systems & Design or Anvil International Haydon H-Block.

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. 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.

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. Size sleeves for branch piping from vertical risers large enough to permit vertical expansion at the riser.

G. Select duct sleeve sizes to suit requirements of fire and/or smoke 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. 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. 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.

K. 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, Hilti FS-one, 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, smoke damper and combination fire/smoke 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”, “SMOKE DAMPER”, “FIRE/SMOKE 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. This Contractor shall furnish all information and assistance required for the Electrical Contractor to purchase all motor starters that are not specified to be part of the mechanical equipment.

E. Control wiring shall be provided under this Division of the work.

F. 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. Perform field mechanical balancing in accordance with Section 23 0950: TESTING AND BALANCING OF MECHANICAL SYSTEMS.

B. 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 23 0200

SECTION 23 0210
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 seamless, 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)

<u>NOTE:</u> VICTAULIC PIPE SHALL BE ALLOWED IN THE BOILER ROOM PIPING AND BETWEEN THE AIR-COOLED CHILLER(S) AND PENTHOUSE MER.

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, and for elimination of flexible connectors. Victaulic Installation-Ready Style 177 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.

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 and installation of product. 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.

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. Manufacturer's Standard (flexible) couplings may be used 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 class125 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 Gruvlok 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 (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.

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 as manufactured by J.J. McNally, Inc., Flexonics, Inc., Metraflex, Hyspan, Twin City Hose, Inc.

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 ™" 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**
40	**94.1**	**94.1**	**92.4**	**94.1**	**94.1**	**92.4**
50	**94.1**	**94.5**	**93.0**	**94.1**	**94.5**	**93.0**
60	**94.5**	**95.0**	**93.6**	**94.5**	**95.0**	**93.6**
75	**94.5**	**95.0**	**93.6**	**94.5**	**95.4**	**93.6**
100	**95.0**	**95.4**	**93.6**	**95.0**	**95.4**	**93.6**
125	**95.4**	**95.4**	**94.1**	**95.0**	**95.4**	**94.1**
150	**95.4**	**95.8**	**94.1**	**95.8**	**95.8**	**95.0**
200	**95.4**	**95.8**	**94.1**	**95.8**	**96.2**	**95.0**

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.

1. Air vents shall be automatic in operation when located in Boiler Rooms, Chiller Rooms and 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. Bottom of pipe shall remain level for steam 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. Strainers shall be installed on suction of all pumps, inlets of control valves, and where indicated on drawings.

O. Thermometers and gauges shall be installed where indicated on the drawings, required by equipment specifications and where indicated elsewhere in the specifications.

P. Flexible connectors shall be provided on suction and discharge piping of all base mounted pumps.

Q. Unions shall be provided adjacent to all valves, at equipment connections, and where necessary to facilitate dismantling of the piping system.

R. 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 compensators and moment guides. Pipe centerlines shall be aligned.
2. During initial system pressurization, all pipe guides and anchors must be secure and functioning.

S. 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 Boiler Room and between air-cooled chiller(s) and penthouse MER)
2. Chilled Water Supply & Return Piping:
   a. Schedule 40 black steel.
   b. Type L hard copper.
   c. Grooved End black steel. (Only permitted in Boiler Room and between air-cooled chiller(s) and penthouse MER)
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 Boiler Room and between air-cooled chiller(s) and penthouse MER)
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 Boiler 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 23 0210

SECTION 23 0215
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, 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.

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

OR

Alternative Check Valves (2-1/2" and larger) shall be Class 125/250, iron body, bronze mounted, Wafer Check Valves, with ends designed for flanged type connection, aluminum bronze disc, EPDM seats, 316 stainless steel torsion spring, and hinge pin.

Recommended valves:

Stockham WG-971

Center Line CLC

Mission K12 HMP

Marlin A125 HZDSF

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

OR

Alternative for the above listed check valves shall be Class 125/250 iron body, bronze mounted, Wafer Check Valve, with ends designed for flanged type connection, aluminum bronze disc, EPDM seats, 316 stainless steel torsion spring, and hinge pin.

Recommended valves:

Stockham WG-971

Mission K12 HMP

Center Line CLC Series

Marlin A125 HZDSF

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-TypeStrainer 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” thorugh 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.

3.2 TAGS, CHARTS AND IDENTIFICATION

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

END OF SECTION 23 0215

SECTION 23 0230
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 23 0200 for HVAC General Provisions

C. Refer to Section 23 0210 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. Exterior Piping
10. Acoustic Duct Liner
11. Reusable Valve Covers
12. Insulated Pipe Saddles

B. Insulation shall be installed on the following duct systems:

1. All supply ductwork.
2. All return 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 23 0200 for a general description of requirements applying to this section.

1.4 QUALITY ASSURANCE

A. Refer to Section 23 0210 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 23 0200.

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, Proto Corp., 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, Aeroflex USA, Inc.

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-manufactured 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.

2.3 KITCHEN HOOD DUCT INSULATION & FIRE RATED AIR DUCTWORK

A. Materials: Non-mineral wool, passive, low biopersistant fiber, ceramic blanket insulation totally encapsulated on all sides with aluminum foil scrim on kitchen hood exhaust duct.

B. Installation shall be 1 layer, 2" thick to provide 2-hour protection on grease duct. Apply directly to the duct with zero clearance to combustibles at the overlap.

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 Fast Wrap Plus, ETS Schaefer or Pyroscat.

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 or flexible elastomeric closed cell foam made with an EPA approved anti-microbial.

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.

G. Manufacturers: Owens Corning QuietR® AcousticR™ Duct Liner, Certainteed, Evonik Industries Solcoustic, Johns Manville Linacoustic® RC, Armacell.

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
½ - 3-1/2	3.75	9	6	20
4 – 6	3.75	12	9	18
8 – 18	5.0	18	12	16
20 – 30	5.0	24	18	14

I. Manufacturer: Tru-Balance insulated saddles as made by Buckaroos, Inc., Aerofix-U as made by Aeroflex USA, 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:

   1/2" 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

   Suction Line:

   1/2" for piping 1-1/4" and below

   1" for piping 1-1/2" and larger

   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.

   a. HVAC: Chilled water piping designated on the drawings.

   b. Equipment drain piping.

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.)

Suction Line:

1/2" for piping 1-1/4" and below

1" for piping 1-1/2" and larger

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. ½” 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 23 0230

SECTION 23 0300
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 Fans
5. Rooftop AHU's
6. Ductwork and equipment

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 minimum Kx/Ky (Horizontal-to-Vertical spring rate) of 1.0. A neoprene pad having a minimum thickness of 1/4" shall be bonded to the baseplate. Amber/Booth Type CPF with RSW-1.

B. Piping in Mechanical Room, In-Line Pumps:

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.

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 Fans

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 1" deflection. To prevent leaks, rails shall be factory assembled (to the limits of freight carriers) and shipped as a one- piece unit.

F. Ductwork and Equipment Lagging:

1. The barrier shall be constructed of 0.10” thick barium sulphate loaded limp vinyl sheet bonded to a thin layer of reinforced aluminum foil on one side.

2. The barrier shall have a nominal density of 1 psf and shall have a minimum STC rating of 28.
3. The barrier shall exhibit minimum flammability ratings of 0.0 seconds for flame out and after glow and 0.2 inches for char length when tested in accordance with Federal Test Standard No. 191-5903.
4. The barrier shall have a minimum thermal conductivity "K" value of 0.29 and a rated service temperature range of 40°F to 220°F. When tested for Surface Burning Characteristics per ASTM E84, the barrier will have a flame spread index of no more than 10 and a smoke development index of no more than 40.
5. The decoupling layer shall be a combination of 1" fiberglass batting, non-woven porous scrim-coated glass cloth, quilted together in a matrix of 4" diamond stitch pattern which encapsulates the glass fibers. The barrier shall be Type KNM-100-ALQ-1 and the decoupling layer shall be type KFA by Kinetics. The composite material shall be fabricated to include a nominal 6" wide barrier overlap tab extending beyond the quilted fiberglass to facilitate a leak-tight seal around field joints. Nominal barrier width 54", nominal decoupler width 48".
6. Sound Transmission Loss: Tested as a free hanging barrier (ASTM E-90-90)

	Frequency, Hz						
Product	125	250	500	1000	2000	4000	STC
KNM 100ALQ-1	13	16	24	33	43	49	28

G. 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.
6. Ensure that the outer surface of the equipment or duct is clean and free of dust, dirt or similar foreign matter. If desired, the outside surface can be painted with a rust-resistant paint in order to minimize potential corrosion.
   a. Field cut and apply the insulation decoupler to the outside of the duct. Obtain a uniform thickness by butting all seams together (do not overlap). At elbows or similar transitions, field measure and miter cut the insulation to fit. Ensure that the insulation is not compressed by the fastener used, if any.
   b. Wrap the noise barrier around the equipment housing or insulation-wrapped duct. At all

seams, overlap the barrier by a minimum of 2" and adhere using adhesive. Alternately, the barrier can be butted together at joints with the seam covered by a 2" (50 mm) wide cut piece of the barrier material. This strip is then adhered to the barrier on either side of the seam using adhesive.

c. If desired, metal or nylon bands can be wrapped around the outside of the barrier to guard against the potential of adhesive failure. If used, this banding should be placed on either side of all radial seams in addition to the midpoint on longer sections. Ensure that the banding is snug only and does not result in compression of the insulation decoupler beneath.

d. In lieu of banding, insulation "stick pins" can be used to reinforce the seams in the noise barrier. Ensure that the pin does not compress the insulation or barrier material beneath.

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 23 0300

SECTION 23 0400
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.

E. Hydronics Institute Boiler Testing Standards:

1. BTS-2000 – Method to Determine Efficiency of Commercial Space Heating Boilers.

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 one year of factory service on boilers.
2. The primary cooper-fin tube heat exchanger shall carry a 5-year limited warranty, and a 20-year warranty against thermal shock.
3. The secondary 316L heat exchanger shall carry a 3-year limited warranty.
4. The burner shall carry a 10-year limited warranty.
5. All other parts shall have a 1-year limited warranty.
6. The manufactured heating units, equipped with a pressed-tubular heat exchanger constructed of stainless steel and a welded stainless-steel manifold, shall be warranted by the boiler manufacturer to be free from defects in material and workmanship under normal usage for a period of ten years from the date of original installation.

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. Boilers shall be CSA design certified as a condensing boiler. Boilers shall be designed for a minimum of 3:1 continuous turn down with constant CO2 over the turndown range. The boiler shall operate with natural gas or propane and have a CSA certified input rating as noted on the drawings, and a thermal efficiency rating of 85% at rated input and 94.3% at minimum input. The boiler shall be symmetrically air-fuel coupled such that changes in combustion air flow or flue flows affect the BTUH input without affecting combustion quality. The boiler will automatically adjust input for altitude and temperature induced changes in air density. The boiler will use a proven pilot interrupted spark ignition system. The boiler shall use a UL approved flame safeguard ignition control system using UV detection flame

sensing. The design shall provide for silent burner ignition and operation. The boiler shall be down fired counter flow such that formed condensate always moves toward a cooler zone to prevent re-evaporation. An aluminum corrosion resistant condensate drain designed to prevent pooling and accessible condensate trap shall be provided.

1. Factory-packaged unit, complete with jacket, gas manifold, burner, and controls mounted and wired, as specified in this section.
2. The complete boiler shall be factory fire tested by the manufacturer and a copy of the firetest report shall be supplied with the unit.
3. The primary heat exchangers shall be constructed in accordance with Section IV of the ASME code, with straight, integral copper-finned tube constriction and a gasketless header at the top and bottom.
4. The primary heat exchanger design must allow for access and replacement of each individual tube.
5. The wall thickness of the primary heat exchanger tubes shall be no less that 0.072" with fin spacing of no less that 7 fins per inch.
6. The heat exchanger shall encompass the entire burner and be enclosed in stainless steel with a fully water-backed tube sheet.
7. Each boiler shall be contained in a minimum 16-gauge negative pressure steel jacket protected with a powder-coated finish. The unit shall be able to operate with any jacket panels removed during inspection or maintenance periods.
8. The boiler shall have a minimum of 96% thermal efficiency as listed in the Equipment Schedule of the Contract Documents.
9. The boilers must have third party (BTS-2000) certification of efficiency and documentation to be supplied to Owner.
10. All condensing in the boiler shall take place in a secondary heat exchanger. The secondary heat exchanger material shall be made of 316L stainless steel. Proper condensate removal shall be incorporated in the design to remove all condensate form the unit.

B. Construction

1. The boiler shall be constructed in accordance with the latest requirements of the ASME Boiler and Pressure Vessel Code and shall be stamped with ASME Symbol. Maximum boiler working pressure shall be 160 psig at 250°F temperature.
2. The boiler shall be factory assembled and shall be shipped to the job location complete with burner and jacket assembled at the factory and all trim mounted and wired. The complete section assembly shall be hydrostatically pressure tested before shipment in accordance with Section IV of the ASME Boiler and Pressure Vessel Code. The boiler shall be factory fire-tested before shipment and the burners shall provide 12 to 12-1/2% CO_2 with a trace to a No. 1 smoke on the Bacharach scale. Boiler shall be equipped with lifting lugs to facilitate lifting and positioning of the boiler.
3. The water boiler shall be provided with built-in air elimination system to assure positive separation of air from circulating water. The water boiler shall be constructed to provide balanced water flow through the entire section assembly so that single supply and return connections can be employed.
4. The boiler shall be provided with an insulated heavy gauge steel jacket with durable baked enamel finish. The jacket shall be easily removable and insulated with minimum 1-1/2" thick foil backed fiber glass on the front, back, top and side panels.
5. The boiler shall be furnished with a factory mounted burner assembly with a refractory mounting

plate which shall be provided with the necessary holes and tappings to mount the burner, including ceramic port if required. The burner backing plate shall be fixed or hinged for access to the furnace.

6. Service Access: The boiler shall be provided with access covers for easily accessing all serviceable components. The boiler shall not be manufactured with large enclosures, which are difficult to remove and reinstall. All access must seal completely as not to disrupt the sealed combustion process. All components must be accessible and able to adjust with the removal of a single cover or cabinet component.
7. Indicating lights: Include a diagnostic control panel with a full text display indicating the condition of all interlocks and the BTUH input percentage. Access to the controls shall be through a completely removable cover leaving diagnostic panel intact and not disrupted.

C. Boiler Trim:

1. Boiler Controls:
   a. The boiler shall be furnished with operating limit, and safety high limit (manual reset) temperature control. The low temperature limit control shall be set according to the design of the heating system.
   b. The boiler shall be furnished with a 3-1/2” dia. combination pressure- temperature gauge to indicate boiler water temperature, system pressure.
   c. The boiler shall be furnished with an ASME certified pressure relief valve and the valve shall be set to relieve at pressure schedule on the drawings. The relief valve shall be of the side outlet discharge type. The relief valve outlet shall be piped to a floor drain per applicable building codes.
   d. All electrical safety boiler controls are to be of accepted quality manufacture bearing U.L. certification.
   e. The Boiler shall be furnished with a U.L. certified low water fuel cut-off. The low water fuel cut-off shall have an ASME working pressure rating of at least the ASME working pressure of the boiler. The low water fuel cut-off shall be installed according to the manufacturer's instructions.
   f. The boiler shall be furnished with a water flow switch to prevent burner operation during low flow conditions.
2. Burner: (Boiler Manufacturer’s Standard)
   a. The packaged Natural Gas (NG) burner shall be U.L. certified and shall be of a design which produces flame retention with rapid intimate mixing of the fuel and combustion air. The burner shall be designed to insure high efficiency and good performance under either balanced draft or forced draft venting conditions.
   b. The burner shall be arranged for modulating operation with pre-purge, low fire start, post-purge and air control. The burner shall be furnished with a pre-wired NEMA 1 control panel which incorporates an annunciating type electronic combustion control with display, electronic flame detector with UV sensor, control circuit transformer, alarm bell with silence switch, flame failure, low water alarm relays and motor starter, electronic combustion safeguard burner primary control, electronic flame detector with UV sensor and motor starter relay. The burner shall be factory fire-tested to ensure proper operation before shipment.
   c. Radiant non-corroding ceramic burner, with no morving parts. Burner operation shall be Full Modulation with minimum 3:1 turn down utilizing a VFD and air-fuel ratio valve for dependable, repeatable modulation.

d. Interrupted-type mixed fuel/air pilot system with electric spark-to-pilot ignition that utilizes a UV scanner to prove pilot before main gas valve open.

e. The entire firing control sequence shall be monitored by a UL approved, commercial-type microprocessor flame safeguard programmer with first fault annunciation and diagnostic indicator lights. Furnish pre-purge and post-purge timing. Shut down burner in the event of ignition pilot and/or main failure with manual reset.

f. Full frontal access port shall be provided for the control area.

g. The boiler will be equipped with a non-sparking blower manufactured with a cast aluminum housing.

h. Combustion air pressure switch shall be provided.

i. The blower shall be equipped with a replaceable combustion air filter, 99% efficient to one micron. The unit will have the capacity of sealed venting.

j. The noise level rating for a single boiler at full fire shall be no more that 60dB.

3. Gas valve train: Refer to detail on the drawings.

a. Gas train shall meet UL 795, CSD-1 requirements.

b. Pilot Gas Train (Mounted, Piped and Wired): A separate pilot gas cock, gas pressure regulator and pilot safety shutoff gas valve shall be provided for the ignition gas supply.

D. Boiler shall be provided with the following options:

1. Aluminum Condensate Receiver Pan
2. Low Air Pressure Switch
3. Blocked Flue Detection Switch
4. Manual Reset Low Water Cut Off (CSD-1 Factory Mounted and wired)
5. Modulation Control
6. Temperature/Pressure Gauge
7. Manual Reset High Limit
8. Air inlet filter
9. Inlet/Outlet Temperature Display
10. Full Digital Text Display for all Boiler Series of Operation and Failures
11. Variable Frequency Drive and Combustion Air Fan
12. Condensate Drain, Drain Trap, and Neutralization Basin.
13. Air Inlet hood for exterior termination of air intake pipe.
14. Vent termination hood for exterior termination of vent pipe.

E. Guarantee: The boiler shall be provided with start-up by factory trained personnel and a full one year factory service to begin at start-up. The boiler shall be warranted for a minimum of twenty (20) years against thermal shock damage, non-pro-rated.

F. Manufacturers: Hydrotherm KN series, Aerco KC-1000, Lochinvar Corp.- IntelliFin Series, Buderus SB Series, Ajax Boiler, Inc. Atlas Series, Gas Master Industries, Inc., RBI Futera, Thermal Solutions EVCA.

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 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 23 0400

SECTION 23 0410
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 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 MATERIALS

A. Provide miscellaneous materials and products of types and sizes to comply with 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 230410

SECTION 23 0450
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. Ductless Split System Heat Pump Units
3. Condensing Unit (Less than 10 tons)
4. Condensing Unit (10-20 Tons)

B. Provide complete refrigeration system including chillers, 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.

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 and labor, 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 indictor, 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-Ft^2 - ˚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 for vibration-free operation. 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 pumpdown 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. Hot Gas By-Pass: Permits continuous, stable operation at capacities below the minimum step of unloading to as low as 5% capacity (depending on both the unit & operating conditions) by introducing an artificial load on the evaporator. Hot gas by-pass is installed on only one refrigerant circuit.
8. Sound Reduction (Factory installed): Compressor Acoustic Sound Blankets

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 DUCTLESS SPLIT SYSTEM HEAT PUMP UNIT

A. The evaporator coil shall be nonferrous construction with smooth plate fins bonded to copper tubing. The tubing shall have inner grooves for high efficiency heat exchange. All tube joints shall be brazed with phoscopper or silver alloy. The coils shall be pressure tested at the factory. A condensate pan and drain shall be provided under the coil. The unit shall be furnished with integral condensate pump with 27” minimum lift, factory mounted and wired.

B. The unit shall be constructed from galvanized steel that is insulated internally and externally with fire-resistant acoustic insulation.

C. The control system shall be microprocessor based. The wall-mounted remote control enclosure shall include an LCD display providing a continuous display of operating status and condition. An keypad for setpoint/program control, unit ON/OFF, and fan speed shall be located below the display.

1. The auto restart feature shall automatically restart after a power failure.
2. The control shall have temperature control setpoint for cooling function with a minimum 2 deg. F differential. The temperature control setpoint range shall be 60 deg. F to 85 deg. F.
3. The LCD display shall provide an ON/OFF indication, fan speed indication, operating mode indication (cooling, dehumidifying) and current day, time, temperature and humidity (if applicable) indication.

D. Direct Expansion System Components:

1. The evaporative coil shall be constructed of copper tubes and aluminum fins. The coil shall be provided with a drain pan.
2. The refrigeration system shall consist of a hermetic compressor, pressure safety switches, externally equalized expansion valve, and a refrigerant sight glass and moisture indicator.
3. Low ambient control will allow cooling to 0 deg. F outdoor temperature.

E. Remote Air-Cooled Condenser: The condenser coil shall be constructed of copper tubes and aluminum fins, and a direct-drive centrifugal fan. No piping, brazing, dehydration or charging shall be required. Condenser electrical connection shall be by a factory wired plug. Fan shall be sized to provide full rated cooling capacity at 95 deg. F entering air. Provide wire guards on condenser coil and fan discharge.

F. Features:

1. Branch duct knockouts on the sides of the chassis for remote discharge of supply air.
2. Fresh air inlet knockout for connection of ventilation air directly into the unit without the need for an inline booster fan. If the length of ductwork exceeds ten feet, provide a booster fan as scheduled on the drawings.
3. Condensate system shall contain a float switch to automatically shut down the cooling operation if the condensate level reaches an overflow condition.

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 heating with manual changeover, as scheduled on the drawings.

H. Manufacturers: Airdale, Carrier, Daikin McQuay, EMI, Hitachi, LG HVAC, Mitsubishi Electric, Panasonic, Sanyo Air Conditioning Products, Samsung.

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 CONDENSING UNIT (Less than 10 Tons)

A. General:

1. Provide air-cooled condensers 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. Leak, pressure and functionally tested at the factory to assure a trouble-free start-up after installation.
5. In current production with published literature available to check performance, limitations, specifications, power requirements, dimensions, operation and appearance.

B. 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.

C. Condenser Fan Motors:

1. Shall be directly connected to the condenser fans.
2. Shall have permanently lubricated ball bearings.
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.

D. The wiring for each unit shall include:

1. A 24-volt temperature control circuit.
2. High and low pressure circuits.
3. Condenser fan motor controls to assure stable operation of ambient temperatures down to 0 degrees F.
4. Condenser fan and compressor contactor.

E. The refrigerant piping for each system shall include:

1. A strainer-drier,
2. A moisture indicating sight glass, and
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.

F. Manufacturer: Carrier, Lennox, Daikin McQuay, Trane, York.

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.

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, and
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, Lennox, 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 DUCTLESS SPLIT SYSTEMS

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 23 0450

SECTION 23 0500

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, tappings 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, tappings 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-lines 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 andv 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 or removal. Verify space required for bundle removal.

K. Manufacturer: Bell & Gossett, Spirovent®, 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 ¾” 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 ½” 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 2½” 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 BYPASSES

A. Three-valve bypasses shall be provided in piping at main system control valves, at control valves for heat exchangers, domestic hot water generators, central station air handling units, and where indicated on drawings.

B. The bypasses shall consist of two gate valves and one globe or angle valve. The bypass pipe size shall be at least equal to the control valve size.

3.3 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.

3.4 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.

3.5 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 23 0500

SECTION 23 0510
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 and hot water 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 12 months after acceptance, including not less than four service calls and written status reports. Minimum service during construction/start-up shall be 8 hours.

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. Log Forms: Provide one-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 ($Si0_2$)	_____
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 or 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 140ºF to 180ºF - 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 one year after completion and acceptance of the water treatment equipment installation. This maintenance service shall begin concurrently with the guarantee. Maintenance work shall be performed by skilled personnel directly employed and supervised by the same company that provided the water treatment equipment specified herein.

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 23 0510

SECTION 23 0600
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. Double Wall Round Duct
4. Flexible Air Duct
5. Fume Hood Exhaust Ductwork - Laboratory Fume Hood and Canopy Hood
6. Flexible Connections
7. Dampers
8. Fire Dampers
9. Combination Fire/Smoke Dampers or Smoke Dampers
10. Air Diffusers, Registers and Grilles
11. Louvered Penthouses
12. Roof-Mounted Relief Hoods
13. Prefabricated Roof Curbs and Equipment Supports
14. Sheet Metal Exhaust Hoods
15. Louvers
16. Sound Attenuation
17. Duct Access Doors (Interior)
18. Duct Access Doors (Exterior)
19. Fabric Air Dispersion Ductwork
20. Remotely Operated Balancing Dampers

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 ¼”.

   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-l 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 galvannealed, 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.
3. Option: Factory fabricated grease duct system, U .L. listed, which meets all the requirements of NFPA 96.

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 galvannealed, 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 connections or Vanstone angle ring connections (the above-mentioned joints), there are proprietary connections that may be used, as long as they meet the pressure criteria set forth in this specification.

2.3 DOUBLE WALL ROUND DUCT

A. Double wall round duct will be constructed of perforated inner liner, a 2 layer of fiberglass insulation, and an outer pressure shell. Duct will be spiral lock seam construction provided in standard 10 foot lengths. It will be fabricated from galvanized steel meeting ASTM-A527 standards, and in accordance with the following guidelines:

Inner Diameter (Inches)	**Outer Shell Min. Gauge (2-10 inches WG)**	**Inner Gauge**	**Fitting Gauge**
3-8	26	26	24
9-12	26	26	24
13-24	24	26	24
25-34	22	26	24
36-42	20	26	22
44-58	18	22	22
60-82	18	22	20

B. For 2-inch insulation, the outer shell will be 4 inches larger than the inner liner nominal dimension. When a perforated liner is specified, perforations will be 3/32 inch in diameter with an overall open area of 23 percent. Insulated duct will have a maximum thermal conductivity (k) factor of 0.27 Btu/Hr./SF/inch at 75 deg. F mean ambient temperature.

C. Follow SMACNA Table 3-2A for Positive Pressure and Table 3-2B for Negative Pressure.

D. Joints:

1. Duct up to 16" 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. The inner liner slip connection shall be a minimum of 2" longer than the outer wall slip connection. Sealant is not required on the inner wall slip.
2. Duct 17" - 60" diameter, - Accuflange@ joint as manufactured by Accuduct, Inc. Installation is to be per manufacturer's recommendations. Companion angle Vanstone with full face gaskets having bolt holes punched through prior to insertion of bolts may be used in lieu of Accuflange. Gasketing to be 1/8" thick. Joint is per SMACNA Figure 3-2, joint RT -2 and RT -2A.

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

Note: Type RT-2 or RT-3 joints are acceptable for concealed work or exposed in Mechanical Rooms. For exposed work in finished spaces, use RT-3 only for a cleaner looking joint.

2.4 FLEXIBLE AIR DUCT

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. Manufacturer: Flexmaster USA

2.5 FUME HOOD EXHAUST DUCTWORK - LABORATORY FUME HOOD AND CANOPY

A. Type 304 stainless steel with 2B finish for exposed work in finished areas; 2D finish for concealed work and work above roof.

B. Metal gauge per SMACNA Standard, liquid-tight welded construction, continuous exterior weld for all seams and joints.

C. General material requirements per ASTM A480 and A276 for 300 series alloys.

2.6 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.

2.7 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 shall be Ruskin Model MD35.

D. Approved Manufacturers: Ruskin, Arrow, Nailor-Hart, Pottorff, Lloyd Industries, Inc., Cesco Products, Louvers & Dampers, United Enertech.

2.8 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 ½ 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.

2.9 COMBINATION FIRE/SMOKE DAMPERS

A. Combination fire/smoke dampers shall be parallel blade, steel damper, factory assembled with fusible link rated for 165 deg. F and 1-1/2 hour unless noted otherwise.

B. Standards: Design and construction of damper assembly shall conform to:

1. UL555
2. UL555S
3. NFPA 90A
4. AMCA Std. 511.

C. Construction shall be:

1. 16-gauge galvanized steel frame.

2. 22-gauge galvanized steel blades
3. Bronze oilite bearings.
4. Stainless steel closing springs.
5. 14-gauge galvanized steel wall sleeve.
6. Stainless steel side seals.

D. Basis of design shall be Prefco Model 5800 MB2 Electric Motor actuator, 120V, Belimo Air Controls, Inc. Model FSNF120

E. Provide end switch to indicate damper position. Locate damper operator on exterior of duct and link to damper operating shaft.

F. Manufacturers: Fire smoke damper shall be Prefco Products, Inc., Model 5050-1, Ruskin, Air Balance, Lloyd Industries, Inc., Pottorff, Cesco Products, Greenheck, United Enertech.

OR

2.9 SMOKE DAMPERS

A. Fabricate in accordance with NFPA 90A and UL 555S, and bear seal for AMCA Std. 511 compliance. Smoke dampers shall be listed and labeled.

1. Dampers: UL Class 1 multiple blade type damper, normally open automatically operated by electric actuator. Provide electric actuator with damper. Provide end switch with any damper which would block total supply airflow if closed.
2. Operator shall be 24 VAC with spring return on power failure and feedback feature to monitor damper position, Belimo Air Controls, Inc., Model FSAF24.
3. Provide interface with Building Fire Alarm System.

B. Manufacturers: Prefco Products, Inc., Ruskin, Air Balance, Lloyd Industries, Inc., Pottorff, Cesco Products, Greenheck, United Enertech.

2.10 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. Perforated face radial air diffusers shall be nominal 24x24 or 24x48 module size with borders suitable for lay-in ceiling tile application. Diffusers shall provide two-way blow. Provide diffusers with 51 % free area perforated face, 3/16" diameter holes on 1/4" staggered centers. Diffusers shall be heavy gauge steel back pan, maximum 6" deep and face maximum 5/8" deep reveal on face plate. Finish shall be factory primed and painted white.
   a. Face and air chamber shall be provided with two retainer cables.
   b. Manufacturer: Price HCF
2. 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: Price Model SMD

3. 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.
4. Round Cone Diffusers:
   a. Adjustable round cone diffuser, welded steel construction with round neck and removable inner assembly of cones.
   b. Air pattern shall be field adjustable from horizontal to vertical.
   c. Finish: Matte white finish
   d. Price Model RCD

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 11/4-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. Price Model 22

4. Ceiling Return Register (CR):
   a. Ceiling registers 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. Price Model PDDR
5. Supply, Return, Exhaust and Transfer Grilles (SG, RG, EG & TG):
   a. Grilles shall be available parallel to the long dimension of the grille. Construction shall be of steel with a 11/4-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. Price Model 520FL(SG), 535 FL(RG,EG & TG)
6. Ceiling Return Filter Grille (CR):
   a. Return filter grilles shall be of size and mounting type as shown on the drawings and schedules.
   b. Return grilles shall provide minimum free area of 90%.
   c. Borders shall be constructed of heavy extruded aluminum with countersink holes or frame suitable for ceiling finish in each room.
   d. The four corners shall be interlocked and mechanically staked to form a rigid frame.
   e. Aluminum grid core shall have ½ x ½ x ½ inch openings
   f. 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.
   g. Return grille finish shall be white powder coat.
   h. Price Model 535FF

D. Manufacturers: Provide diffusers, registers and grilles of one of the following:

Anemostat	Price
Carnes Co.	Titus
Krueger	Tuttle & Bailey
Metalaire	Nailor Industries

2.11 LOUVERED PENTHOUSES

A. Louvered penthouses shall be fabricated of extruded aluminum sections and formed aluminum sheets. The louvers shall be heavy gauge extruded aluminum of the storm-proof style with comers mitered and heli-arc welded. Roof and curb caps shall be formed of heavy gauge aluminum sheets, and the entire assembly shall be braced with heavy interior upright angles at the comers and along the sides.

B. An extruded aluminum metal bird screen shall be provided at interior face of louvers.

C. Self-acting, non-chattering aluminum backdraft dampers shall be provided inside penthouse when used for gravity or pressure relief. The dampers shall open from an internal pressure not to exceed 0.05 inches of water gauge.

D. Penthouse roof shall be insulated with one inch of fiberglass or equivalent material to retard condensation.

E. Penthouse shall be equipped with an all weather shield to protect against wind whipped rain and snow, and also serve as a condensate drain trough.

F. Access to interior of penthouse shall be provided through a removable louver section.

G. Provide 12-inch-high insulated roof curb with blocking to secure equipment, and integral cant to accommodate configuration of roofing material/membrane.

H. Penthouse shall be manufactured by Penn Ventilator Co., Construction Specialties Co., Carnes Company, Airpath Products Co., United Enertech.

2.12 ROOF-MOUNTED RELIEF HOODS

A. Heavy gauge aluminum construction.

B. Hinged hood.

C. Hood underside insulated with 1" fiberglass

D. Aluminum insect screen

E. Provide 12-inch-high insulated roof curb with blocking to secure equipment, and integral cant to accommodate configuration of roofing material/membrane.

F. Manufacturers: Penn Ventilator Co., "Airette", Carnes Co., Greenheck, Loren Cook or Acme

2.13 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. 8” to 11” 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., PHP Systems/Design.

2.14 SHEET METAL EXHAUST HOODS

A. Hoods shall be type and size as shown on drawings.

B. Canopy hoods shall be 16-gauge steel mounted 6'-0" above finished floor with a minimum 8" drop curtain or as shown on drawings.

C. Wall mount or equipment hoods shall be 14-gauge steel supported and braced on 40" maximum centers. Hood size and configuration shall be as shown on drawings.

D. All hoods shall be welded construction with all welds ground smooth.

2.15 LOUVERS

A. All wall louvers for intake and exhaust shall be stationary stormproof type.

B. Construction shall be of extruded aluminum with 0.081-inch-thick blades and frames and all fastening shall be aluminum or stainless steel.

C. An aluminum expanded metal bird screen with frame shall be secured to the rear face of the louver assembly.

D. Depth of the louver frame shall be 4" unless otherwise indicated.

E. Performance Rating:

1. Free Area: Louvers shall have a minimum of 50% free area based on a 48-inch-high by 48-inch-wide size.
2. Air Performance: Not more than 0.08 inch WG static pressure drop at 700 FPM free area intake velocity.
3. Water Penetration: Maximum of 0.01 ounces per square foot of free area at an air flow of 750 feet per minute free area velocity when tested for 15 minutes.

F. The surface areas shall be factory anodized finish of color selected by Architect.

G. Manufacturers: Airstream Products Co., Air Balance, Inc., Carnes Co., Arrow Co., Empco, Pottorff, Cesco, Lloyd Industries, Inc., Ruskin, Louvers & Dampers, United Enertech, NCA Manufacturing, Inc.

2.16 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, Vibro-Acoustics.

2.17 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.

2.18 DUCT ACCESS DOORS (Exterior Locations)

A. Duct access doors shall be fabricated with 20 gauge inner panels and 16 gauge outer panels of galvanized steel. (option: aluminum or bonderized steel)

B. Frames shall be fabricated of extruded aluminum with internal lateral supports.

C. Inner and outer door frames shall provide a non-metal-to-metal separation for thermal and air leakage performance at both low and high static pressure differentials. Doors shall swing to ensure that they open against air pressure.

D. Door insulation shall be 1" thick 3.0 pcf density fiberglass.

E. Dual acting handles shall secure door against double gasketing that is continuously and mechanically bonded to the door frame.

F. Doors shall be attached to frame with continuous piano hinge secured to the frame with stainless steel rivets.

G. Makes: Cesco Products, Karp Co., Larsen Mfgr.

2.19 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.

2.20 REMOTELY OPERATED BALANCING DAMPERS

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 = 1500FPM.
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.

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 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 hangers are not acceptable.
5. Support ductwork from building structure with expansion bolts, rods, steel angles or channels installed to meet existing or new building conditions.
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 LOUVERS

A. Locate and place louver units level, plumb and at indicated alignment with adjacent work.

B. Use concealed anchorages where possible.

C. Provide perimeter reveals and openings of uniform width for sealants and joint fillers.

D. Repair damaged finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alternations and refinish entire unit or provide new units.

E. Protect galvanized and non-ferrous metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry or dissimilar metals.

3.3 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.

3.4 DUCT SYSTEM LEAK SEALING

A. Joints in duct systems at duct heaters, air monitors, fire dampers, sound traps, supply air terminals including air handling light fixtures, 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.

3.5 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

B. All tests shall be conducted in accordance with AABC National Standards.

C. Ducts to be tested at 100% maximum of static pressure before any duct is insulated externally and concealed in accordance with SMACNA Standards.

D. Calculate the allowable leakage using leakage factor of 5% of Design Air Flow.

E. Select a limited section of duct for which the estimated leakage will not exceed capacity of the test apparatus.

F. Connect the blower and flow meter to the duct section and provide temporary seals at all openings of the ductwork.

G. Start the blower motor with the inlet damper closed. Increase pressure until the required level is reached.

H. 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.

I. 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.

J. Complete test reports and obtain Owner's witness signature.

K. Remove all temporary blanks and seals.

L. Warning: Do not overpressure duct.

3.6 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.

3.7 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.

3.8 LABELING

A. At all fire damper, smoke damper and combination fire/smoke 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”, “SMOKE DAMPER”, “FIRE/SMOKE DAMPER” as appropriate for the installation. Attach securely to face of access door with brass screws at each corner, sealed airtight.

END OF SECTION 23 0600

SECTION 23 0605
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. Fans (Utility Set Type)
2. Recessed Ceiling Fan
3. Centrifugal Belt Drive Cabinet Fan
4. Roof-Mounted Exhaust Fans
5. Vertical Discharge Exhaust Fan (Kitchen, Dishwashing)
6. High Plume Dilution Exhaust fan (Fume Hood)

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 FANS (UTILITY SET TYPE)

A. Utility set type fans shall be completely assembled units consisting of a continuously welded steel scroll housing, centrifugal fan wheel, structural steel base and motor combination with inlet and outlet flanges prepunched.

B. Fan wheel shall be multi-blade type with hub and backplate and inlet ring. Entire fan wheel assembly shall be steel or aluminum. Fan blades shall be forward or backward inclined type. Where explosion-proof fans are called for, provide spark-proof fan. Wheel shall be statically and dynamically factory balanced.

C. Scroll housing shall be steel with adjustable discharge feature. Inlet cone shall be spun steel with streamline venturi characteristic. Access door shall provide inspection of wheel and fan interior, fully hinged with multiple closures.

D. Fan motor shall have copper windings and be grease packed ball bearing type of TEFC or open drip-proof construction. Where called for on drawings or indicated in schedule, provide explosion-proof motors.

E. Fan wheel shall be indirectly driven through a V-belt drive, and the drive shall be designed for 150% of the driven load and the motor pulley shall be adjustable pitch type. Where called for on drawings or indicated in schedule, provide explosion-proof motors. Fan shaft shall be ASTM A-108 steel, grade 1018 or 1045.

F. Fans on roof shall be provided with a hinged weather hood over motor and drive, and a drain connection in bottom of scroll housing. The weather hood shall also protect a disconnect switch which shall be factory mounted by the fan manufacturer. Hood shall be vented to reduce heat build-up.

G. Fans shall bear the AMCA seal and shall be manufactured by Acme, Aerovent, American Coolair/ILG, Buffalo Forge, Hartzell, Loren-Cook, Temtrol, Twin City Fan.

2.2 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 plastic ceiling 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, wall cap, roof terminal, metal grille, isolator package, time delay switch with adjustable relay as scheduled on the drawings.

F. Unit shall be AMCA certified.

G. Manufacturers: Loren-Cook, Penn Ventilator, Acme, Carnes, Greenheck, Breidert, Panasonic.

2.3 CENTRIFUGAL BELT DRIVE CABINET FAN

A. Fan shall be centrifugal belt driven in-line type. Fan housing shall be of the square design constructed of heavy gauge galvanized steel and shall include square duct mounting collars.

B. Fan shall be provided with removable service doors located perpendicular to the motor mounting panel. The service doors must be of sufficient size to permit easy access to all interior components.

C. Fan wheel shall be of the aluminum backward inclined, centrifugal type. Wheels shall be dynamically and statically balanced and shall overlap the spun inlet venturi for maximum performance.

D. Motor and drives shall be isolated from the air stream. Motors shall be of the heavy duty type with permanently lubricated, sealed ball bearings. Wheel shaft shall be ground and polished shafting mounted in heavy duty permanently sealed pillow block bearings. Drives shall be sized for a minimum of 165% of driven horsepower. Pulleys shall be of the fully machined cast iron type, keyed and securely attached to the wheel and motor shaft. Motor pulleys shall be adjustable for final system balancing.

E. Flexible wiring leads shall be provided from the fan motor to an external mounted junction box and disconnect switch permitting access for service without disconnecting the field wiring. All fans shall bear the AMCA Certified Ratings Seal for both air and sound performance.

F. Manufacturers: Penn Ventilator, Greenheck, Carnes, Loren-Cook, American Coolair/ILG, Breidert, Hartzell.

2.4 ROOF-MOUNTED EXHAUST FANS

A. Aluminum casing shall be heavy gauge, mill finish of spun construction, weatherproof, removable, with aluminum birdscreen.

B. Aluminum centrifugal fan, adjustable V-belt drive selected for 150% of motor ampere rating.

C. Fans shall be quiet operating, selected for sound level below that of the space ventilated.

D. Accessories: Disconnect switch, insulated roof curb.

E. Manufacturers: Penn Ventilator Co., Greenheck, Loren Cook, Acme, Carnes, Breidert, Hartzell.

2.5 VERTICAL DISCHARGE EXHAUST FAN (KITCHEN, DISHWASHING)

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. The exhaust fan unit shall be AMCA certified and shall be as manufactured by Penn Ventilator Company, Loren Cook, Acme, Greenheck, American Coolair/ILG, Breidert, Hartzell.

2.6 HIGH PLUME DILUTION EXHAUST FANS (CHEMICAL FUME HOODS)

A. Fans shall have been tested in accordance with AMCA Standards 210 and 300 and shall bear the AMCA seal for Certified Sound and Air Performance.

B. Classification for spark resistant construction shall conform to AMCA "C" per Standard 99.

C. Fans shall include a certificate of compliance with these standards prior to shipment.

D. Fans shall provide mixed flow, high plume, vertical discharge and be suitable for roof mounting without the need for guy wire supports.

E. All steel and aluminum parts of the fans shall be cleaned and coated with a minimum of 4 mils of epoxy or polyester resin per fan manufacturer's standards.

F. Each fan shall be direct drive with impeller mounted directly to the motor shaft with motor isolated from the direct exhaust airstream; motor shall be visible and accessible from the fan exterior for inspection and service.

1. Fan impeller shall be combination axial/backward curved blades, welded steel construction with discharge guide vane section, factory balanced.

OR

F. Each fan shall be belt driven, AMCA arrangement 10, with drive belts and sheaves sized for 200% of fan operating brake horsepower, readily accessible for service and adjustment; shaft shall be ANSI C-1045 steel with protective coating, or 316 stainless steel.

1. Fan impeller shall be centrifugal, backward inclined air foil design, factory balanced, coated steel construction.

G. Fan shall include a steel or FRP windband and discharge nozzle to induce outside air up to 270% of fan design flow rate, or provide a high velocity conical discharge nozzle to efficiently handle outlet velocities up to 6000 fpm.

H. All fasteners shall be 316 stainless steel.

I. Fan assembly shall be mounted on an inlet mixing plenum of heavy gauge steel, all welded, with hinged access door and safety screen, aluminum opposed blade bypass damper, with rain hood for introducing outside air at roof level upstream of the fan.

1. Plenum shall be mounted on roof curb or rails with flexible PVC connection between plenum and fan inlet.

2. Damper actuator shall be provided as part of the work of Section 15900 Controls.

J. Isolation shall be limited to rubber in shear pad type devices provided by the fan manufacturer.

K. Fan motors shall be high efficiency, TEFC, with a 1.15 service factor.

L. Fan bearings shall be minimum L-10 life of 200,000 hours with ball or spherical pillow block type sealed to retain lubrication and exclude dust and air, with lines extended to grease fittings outside fan housing.

M. Fan accessories shall include bolted access cover for impeller service, internal drain system to divert rain water away from the building duct connection, NEMA 3R non-fused disconnect switch factory mounted and wired to the motor. Color as selected by Architect from manufacturer's standard color chart.

N. Manufacturers: Axijet-F as made by M.K. Plastics Corporation, Tri-Stack Fan as made by Strobic Air Corporation, Model TCB-LE as made by Greenheck Fan Corp., Model TFE as made by Twin City Fan and Blower or Model TCNHBLE as made by Loren Cook.

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 230605

SECTION 23 0725
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 Unit Heaters
6. Electric Wall Heaters

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 date 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., American Air Filter, Embassy Industries, Daikin McQuay, Modine, Rittling, Sigma, 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., American Air Filter, Embassy Industries, Daikin McQuay, Modine, Rittling, Sigma, Sterling, Trane, Vulcan.

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 configurated 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, Heatcraft, 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 ½” 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 UNIT HEATERS

A. Horizontal Unit: Construct casing of steel, phosphatized inside and out, and finished with baked enamel. Provide motor-mounted panel, minimum of 18 gauge steel. Fabricate casing to enclose heater, louvers and fan blades. Provide individually adjustable louvers for air diffusion.

B. Construct fans of aluminum and factory balance.

C. Metal sheath fin tube electric heating element.

D. Provide totally enclosed motors, with built-in overload protection, having electrical characteristics as scheduled.

E. Provide integral residual heat sensor to continue fan operation until element temperature fall below preset point.

F. Manufacturers: American Air Filter, Electromode, Berko, Indeeco, TPI/Markel, Q-Mark.

2.6 ELECTRIC WALL HEATERS

A. Construct casing of steel, phosphatized inside and out, and finished with baked enamel. Provide motor-mounted panel, minimum of 18 gauge steel, fabricate casing to enclose heater, and fan. Front panel shall be tamperproof style with stamped louver grille. Suitable for recessed or surface mounting.

B. Construct fans of aluminum and factory balance.

C. Metal sheath fin tube electric heating element.

D. Provide totally enclosed motors, with built-in overload protection, having electrical characteristics as scheduled.

E. Provide integral residual heat sensor to continue fan operation until element temperature falls below preset point. Provide unit-mounted thermostat and disconnect.

F. Manufacturers: Q-Mark, Berko, TPI/Markel, Indeeco, Electromode.

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 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.

3.5 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.

3.6 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 23 0950: TESTING AND BALANCING OF MECHANICAL SYSTEMS.

END OF SECTION 23 0725

SECTION 23 0760
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. Single-Packaged, Gas-Fired Rooftop Air Conditioning Unit with Energy Recovery
3. Single Packaged, Gas-Fired Rooftop Air Conditioning Unit
4. 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. AMCA Standard 611 and 610 for air flow measurement stations.

G. ARI Standard 1060 and ASHRAE Standard 84 for Air-to-Air Energy Recovery Equipment.

H. 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 date 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 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 1-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 minimum18-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-valve 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 2" throwaway, pleated filters, 30% standard MERV 6 efficiency, flat or angled arrangement with end covers.
4. All concealed units shall have 1-1/4” discharge duct collar, 1” on return.

C. Fans shall be SWDI, forward-curved, centrifugal blower type equipped with heavy duty adjustable speed direct drive. The fan shaft shall be supported by heavy duty, permanently sealed ball bearings. Fans shall be dynamically balanced.

D. Blower Motor shall:

1. Be 1750 RPM, open dripproof, high efficiency, PSC-type with three separate taps.
2. Have inherent protection, permanently lubricated ball bearings and a service factor of at least 1.15.
3. Be factory mounted within the insulated cabinet and wired to a junction box, factory set to scheduled voltage.
4. Be provided with a factory-mounted and wired three-speed switch and fan speed relay.
5. Factory-mounted and wired disconnect switch.
6. Permit the blower RPM to be adjusted to meet the exact CFM requirement of the system.

E. Water Coils:

1. Main coils shall be two, 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 ¾" 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.

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 SINGLE PACKAGED, GAS-FIRED ROOFTOP AIR CONDITIONING UNIT WITH ENERGY RECOVERY

A. Refrigeration System – Refrigerant R-410A:

1. One independent refrigeration circuit per hermetic compressor, crankcase heater, strainer, high and low pressure control, compressor motor protection, access valves, hot gas bypass, solid core liquid line filter driers. Provide hot gas bypass on one of multi-stage units.
2. A direct expansion, draw-thru evaporator coil shall be circuited so that its entire fin surface will be active during part load operation. Slide-out composite condensate drain pan.
3. Draw-thru condenser coils with a separate sub-cooling circuit for each refrigeration system shall provide at least 15 F of sub- cooling at design conditions.
4. Outdoor air thermostats shall cycle the condenser fan motors to maintain stable operation at ambient temperature down to 35 deg. F. Condenser fan motors shall have inherent protection.

B. Air-to-Air Energy Recovery Module

1. 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 damper, access doors and operating controls.
2. Casing:
   a. Casing panels shall consist of single wall, heavy gauge galvanized solid exterior skins and 2" thick 1.5 pcf fiberglass insulation with a minimum R-value of 10 which meets NFPA 90A and UL181 test standards. All metal-to-metal surfaces exposed to the weather shall be sealed airtight with maximum leakage not-to-exceed 2% at external static pressure of 3" W.C.
   b. Removable panels shall be provided for energy recovery wheels, and fans. The housing shall be supported by an all-welded epoxy-painted structural base. Lifting lugs shall be welded to the base. All frame and panel members shall be G90 galvanized steel.
   c. Access to all internal devices and sections shall be provided through hinged, sealed doors. Access doors shall be constructed of the same materials as the unit casing. Each door shall be provided with two cam type handles and two heavy duty hinges to achieve maximum sealing.
   d. Exterior finish shall be powdered enamel finish electrostatically bonded to the metal.
3. Fans:
   a. Fan ratings are based on tests made in accordance with AMCA Standard 210 and shall bear the AMCA Seal. Fans shall be of the centrifugal type, designed with a scroll type housing. Fans shall incorporate a wheel, structural steel frame and shaft and bearings in the AMCA Arrangement 3 configuration to form a heavy duty integral unit. All fan wheels shall provide stable flow and high rigidity. The wheels shall be non-overloading type. The blades shall be

continuously welded, die-formed backward curved type, designed for maximum efficiency and quiet operation. Impellers shall be statically and dynamically balanced and the complete fan assembly shall be test balanced at the operating speed prior to shipment.

b. Shafts shall be AISI hot rolled steel accurately turned, ground, polished, and ring gauged for accuracy. Shafts shall be sized for first critical speed of at least 1.43 times the maximum speed for the class.

c. Bearings shall be heavy duty, grease lubricated, anti-friction ball or roller, self-aligning, pillow block type and selected for minimum average bearing life (AFBMA L-10) in excess of 100,000 hours at the maximum class RPM.

d. Fans shall be mounted on vibration bases with adjustable motor bases, V-belt drives, minimum 1" static deflection spring isolators, and flexible connections. Belts shall be designed for a minimum 1.5 service factor. Drives for motors shall be variable pitch.

e. Motors shall be standard NEMA frame, design B high efficiency, with 1.15 service factor and open drip-proof enclosures, rated for inverter duty. Motor selections shall be non-overloading over the fan curve from 0 to 150% of design flow, and the design BHP shall not be above 90% of motor horsepower at design condition.

4. Total Energy (Enthalpy) Recovery Wheel:

a. The rotor media shall be made of aluminum which is coated to prohibit corrosion. All media surfaces shall be light weight polymer coated with a permanently bonded Silica gel desiccant prior to being formed into the honeycomb media structure to ensure that all surfaces are coated and that adequate latent capacity is provided. Desiccant coatings that must be reapplied over time are not acceptable.

b. Sensible and latent recovery efficiencies shall be clearly documented through a certification program conducted in accordance with ASHRAE 84-1991 and the results shall be presented in accordance with ARI 1060-2000 Standards. The certification shall have been conducted by the unit manufacturer.

c. Wheel testing to document that the desiccant material utilized does not transfer pollutants typically encountered in the indoor air environment shall be provided. The cross-contamination and performance certification reports shall be provided for as part of the submittals for this project.

d. The media shall be cleanable with low temperature steam, hot water or light detergent, without degrading the latent recovery. Dry particles up to 650 microns shall pass freely through the media.

e. Rotor System:

(1) Seals: The rotor shall be supplied with diameter and perimeter seals which shall not make contact with any rotating surface of the exchanger rotor face.

(2) Rotor Support System: The rotor media shall be provided in segmented fashion to allow for field erection or replacement of one section at a time without requiring side access. The media shall be rigidly held by a structural spoke system made of stainless steel.

(3) Rotor Housing: The rotor housing shall be a structural framework which limits the deflection of the rotor due to air pressure loss to less than 1/32". The housing shall be made of galvanized steel to prevent corrosion. The rotor shall be supported by two pillow block bearings which can be maintained or replaced without the removal of the rotor from its casing or the media from its spoke system. Bearings shall be selected for an L-10 life in excess of 30 years.

(4) Drive System: The rotor shall be driven by a self-adjusting flexible, circumferential belt system. A/C motors shall be utilized.

(5) Assembled system shall incorporate the complete wheel assembly, seals, drive motor and belts in an insulated cassette frame within a slide-out track.

5. Filters:

a. Provide mist eliminators on outside air inlet air hood.

C. BAS Controller: Provided by ATC.

D. Filters shall be 2" thick replaceable type MERV 7 per ASHRAE Standard 52.2 and internal metal frame work, capable of accepting up to 4” filters.

E. A 1,750 rpm single supply air blower motor, rated for inverter duty, 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 25% above the nominal drive horsepower. The fan shaft ball bearings shall have minimum average bearing life (AFBMA L-10) in excess of 100,000 hours at the maximum class RPM. Slide-out blower/motor assembly.

F. Roof Curb:

1. Roof curb shall be minimum 14” high, unless higher curb is required, as supplied by the unit manufacturer to provide a watertight seal between the roof and the unit. Full perimeter, uninsulated, shipped knocked down.

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 for other roof penetrations.

4. Insulated deck under compressor and condenser sections.

G. Unit Construction:

1. All sheet metal parts shall be constructed of a zinc coated, commercial grade galvanized steel. All external surfaces shall be finished with a UL approved coating system. Certified at 1,000 hours salt spray test per ASTM B-117.

2. Removable side or hinged access panel shall provide easy access for maintenance, service and adjustment.

3. Unit shall be single wall construction with foil faced insulation such that insulation is not exposed to the air stream.

4. Unit shall have lifting lugs on each of the four upper corners, or full perimeter base rails with built-in rigging fixtures.

5. Condenser coils and fan discharge shall be protected by heavy duty wire guards.

H. 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.

I. Unit shall be completely factory wired, piped, charged and tested by the manufacturer before shipment. Single point power connections with factory mounted disconnect.

J. Gas Heating Section:

1. Manufacturer shall furnish a natural gas furnace constructed of 20 gauge aluminized steel tubes.
2. Furnace shall include the following controls and safety devices:
   a. Intermittent spark ignition with two stage gas valve with 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.

K. Manufacturer: Trane, York/Johnson Controls, Carrier, McQuay, Valent.

L. 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.

2.3 SINGLE PACKAGED, GAS-FIRED ROOFTOP AIR CONDITIONING UNIT

A. Refrigeration System:

1. One independent refrigeration circuit with hermetic compressor, crankcase heater, strainer, high and low-pressure control, compressor motor protection, and access valves.
2. A direct expansion, draw-thru evaporator coil shall be circuited so that its entire fin surface will be active during part load operation.
3. Draw-thru condenser coils with a separate sub-cooling circuit for each refrigeration system shall provide at least 15 F of sub- cooling at design conditions.
4. Outdoor air thermostats shall cycle the condenser fan motors to maintain stable operation at ambient temperature down to 35 deg. F. Condenser fan motors shall have inherent protection.

B. 100% Outdoor Air (Economizer Package):

1. Outdoor and return air dampers shall be interlocked in position by a fully modulating damper actuator. Actuator shall be spring return so that the outdoor air intake dampers will close when power to the unit is interrupted.
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” WC.
3. The outdoor intake opening shall be covered with a birdscreen and a rain-hood that matches the exterior of the unit.

C. Exhaust Air Relief Dampers:

1. Economizer shall be equipped with barometric dampers that will open to 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.

D. Filters shall be 2" thick replaceable type MERV 8 and internal metal frame work.

E. 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 25% above the nominal drive horsepower. The fan shaft ball bearings shall have minimum average bearing life (AFBMA L-10) in excess of 100,000 hours at the maximum class RPM.

F. 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 for other roof penetrations.

G. Unit Construction:

1. All sheet metal parts shall be constructed of a zinc coated, commercial grade galvanized steel. All external surfaces shall be finished with a UL approved coating system.
2. Removable side panel shall provide easy access for maintenance, service and adjustment.
3. Unit shall be single wall construction with foil faced insulation such that insulation is not exposed to the air stream.
4. Unit shall have lifting lugs on each of the four upper corners.
5. Condenser coils and fan discharge shall be protected by heavy duty wire guards.

H. 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 deg. 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.

I. 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 230900.

J. Gas Heating Section:

1. Manufacturer shall furnish a natural gas furnace constructed of 20-gauge aluminized steel tubes.
2. Furnace shall include the following controls and safety devices:
   a. Intermittent spark ignition with two stage gas valve with 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.

K. Manufacturer: Trane, York/Johnson Controls, Carrier, Daikin McQuay, Greenheck, Lennox.

L. 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.

2.4 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 controlled by a factory mounted and wired damper actuator. 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.
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 Contractor's 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 23 0760

SECTION 23 0861
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. Basis of design is Global Plasma Solutions. 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 (Ti02), 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 (Ti02).
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/GUARANTEE

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

PART 2 – PRODUCTS

2.1 AIR PURIFCATION 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 manufactures requesting prior approval shall provide to the engineer independent test data from a NELAC accredited independent lab confirming kill rates and time meeting the minimum requirements stated. 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 and optionally a BacNet or Lonworks interface as specified on the control drawings. Manufacturers not providing a stand-alone ion sensor shall not be acceptable.
4. Mount and wire the Plasma device within the air handling unit specified or as shown or the drawings. The contractor shall follow all manufacturer IOM instructions during installation.
5. 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, Bio Climatic.

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 23 0861

SECTION 23 0900
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. 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.

1.2 DESCRIPTION OF WORK

A. Provide labor, material and supervision necessary to install a complete direct digital control system of controls with a host PC and full color graphics to control all HVAC Systems, associated components and accessories as described herein. Host PC and accessories shall be furnished by the Owner.

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 ten (10) copies of submittal data within thirty (30) days of contract award.

E. Submittal shall consist of:

1. System Architecture showing all digital and pneumatically 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. Insure 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 135-2016 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. 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.

3. 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., as installed by Albireo Energy. 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. Central Hardware: The central BMCS facility shall be located in Room D113 as shown on the

drawings. The host computer and accessories shall be provided by the Owner. Coordinate with Article 2.9.A.

2.2 TEMPERATURE SENSORS

A. Solid state room sensors shall be of industrial grade negative temperature coefficient thermistor type. Sensors shall be of the completely solid-state type with no moving contacts with the exception of the override switch and slide bar temperature setpoint adjustment lever where they are applied.

1. Space temperature sensors in classrooms and offices shall be equipped with a membrane override switch which is embedded in the sensor cover, and a slide bar temperature setpoint adjustment lever. Microtouch.
2. Space temperature sensors in corridors and stairwells shall be of the stainless steel blank plate type without override switch or setpoint adjustment.
3. Space sensors in Gym, Cafeteria, and Auditorium areas shall be of the stainless steel blank plate type with override switches.

B. Sensors shall be mounted at ADA height (48” above floor), if equipped with accessible adjustments.

2.3 SMOKE DETECTORS

A. Duct type ionization smoke detectors shall be furnished by the Electrical Contractor 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.

C. The Automatic Temperature Control contractor shall 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.

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 industrial grade negative temperature coefficient thermistor 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.

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, Hy-Cal HT Series, or Alerton combination temperature/humidity sensors.

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 WING

A. Host Computer and Operator's Work Station (OWS)

1. The host computer and accessories shall be located in Room D113 as shown on the drawings. 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. Heating System Control:

1. This system consists of two boilers, B-B1 and B-B2, each with boiler circulating pumps P-B2 and P-B3, primary loop isolation valves, and building dual temperature heating/cooling pumps P-B4 and P-B5. 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 and sequencing panel will maintain setpoint of the system at the boiler's control panel.
2. Whenever the outdoor air temperature is at or below 55°F, adjustable, boilers B-B1 shall be enabled and B-B2 shall be on standby. On a call for boiler B-B1 to operate the system isolation valves shall be commanded open, Article 'E', on a proof of open via valve end switch the boiler shall be enabled. B-B2 shall remain in standby. If boiler B-B1 cannot maintain hot water supply setpoint boiler B-B2 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 internal pump operation, and diagnostics. The BAS shall monitor boiler inlet/outlet, outside air temperature, modulation rate setpoint and mixing valve demand percent on the boiler's secondary heat exchanger.
4. When the boiler's integral controls are activated, its internal circulating pump and Pump P-B2 or P-B3 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 boiler/pump set to equalize the accumulated run time.
5. During the unoccupied mode of the building systems, the boilers shall maintain the following status:

Outdoor Temperature	Boiler Status
Less than 65°F	Hot Standby
Above 65°F	Off

a. Whenever any space temperature sensor falls below 45°F, adjustable, during the unoccupied mode, the system shall activate the lead building dual temperature loop pump and lead boiler/boiler pump to provide heat until the setback space temperature is satisfied. If there is no call for heat after two hours (adjustable), the lead pumps and boiler shall be de-activated and return to the off or standby status as scheduled.

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. Primary Dual Temperature Heating/Cooling Water Pumps Control:

1. Pumps P-B4 and P-B5 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. The pumps shall also be subject to a manual command at the OWS. 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 ‘G’ where the branch piping connects to the main risers.
   c. The lead loop pump shall be enabled during the occupied mode, as programmed through the system. The loop pump VFD shall modulate the pump speed to maintain the differential pressure setpoint.
   d. Provide pressure actuated bypass valve at the pumps to maintain minimum flow to prevent the pumps from shutting off as the control valves on the room terminal units close. Set bypass flow equal to approximately 15% of total system flow. Locate bypass in the Room B301.

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 activated automatically according to the following schedule:

Outdoor Temperature	Occupied	Unoccupied
Less than 45°F	ON	ON
45°F to 65°F	ON	OFF

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-B4 Lead - Pump P-B5 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.
   g. Pump bypass valve status: open/closed/alarm.

D. Chilled Water System Control:

1. This system consists of one air-cooled water chiller, CH-B1, dual temperature loop pumps P-B4 and P-B5, primary chiller pump P-B1, and interconnecting piping and accessories. Pumps P-B4 and P-B5 shall be controlled directly by the BAS per a lead/lag sequence as described in article C.
2. The chiller control sequence shall be activated on a rise in outside air temperature above the programmed setpoint of 70°F, adjustable. The chilled water system shall also be manually activated via a software switch at the OWS.
3. When the chiller control sequence is activated, the chilled water 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. The BAS shall sequence the lag chiller and its pump to maintain capacity based on building demand.
   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. When building demand for cooling is satisfied, the BAS shall adjust the chiller setpoint upwards. The BAS shall provide an analog signal (0-10 vdc or 4-20 ma) to the chiller to reset the chiller discharge water temperature setpoint based on building demand.
5. 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.
6. The OWS shall accommodate up to 3 alarm/status inputs from the chiller for monitoring and alarm generation.
7. The BAS shall monitor chilled water discharge and return temperatures for display at the OWS.
8. BAS Contractor shall provide all field control wiring for operation of the chiller.
9. 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. Up to 3 alarm/status inputs for chiller.

e. Chilled water discharge reset setpoint

f. Chilled water pump start/stop command and status via current switch.

g. Chilled water pump flow/alarm per pump via current switch.

h. Chiller on/off command.

i. Heat tape status.

E. 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.

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.

F.1 Domestic Water Heater System Control (Penthouse B301)

1. The domestic water heater located in the penthouse MER 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.

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.

F.2 Domestic Water Heater System Control (MER D118)

1. The domestic water heaters located in Mechanical/Electric Room D118 shall be activated by their

integral temperature controls. Each heater is equipped with sealed combustion air control which does not require any further control interface.

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 each water loop.
3. Provide on/off control for 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 heaters activated/deactivated.
   b. Domestic hot water discharge temperature.
   c. High/Low discharge temperature alarm, heaters and each loop.
   d. General failure signal.
   e. Commanded status of domestic hot water circulator pump.
   f. Pump flow status/failure alarm.

G.1 Penthouse B301 Heating and Ventilation System Control

1. This system consists of unit heaters UH-B1 and UH-B2, and roof mounted exhaust fan EF-B15, and outside air intake IH-B4. 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.

G.2 MER D118 Heating and Ventilation System Control

1. This system consists of unit heater UH-D1 and roof mounted exhaust fan EF-D7, and outside air intake IH-D1. 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.

H. Fan Coil Unit Control

1. Each unit shall be controlled by an individual DDC Controller. 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 flat plate space sensors for units that serve stairways, as well as corridors; no override switch is required in these locations.
2. During the programmed occupied mode, the fan shall run continuously.
   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, 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. Diagram showing the layout of the unit with major components and dynamic temperatures shown where temperature sensors exist in the system.

I. 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 un-occupied mode, the fan shall cycle and the hot water coil control valve 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. 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.

K. Zone Heating Duct Coil Control

1. Duct coils, DC-B1.1 through DC-B1.38, and DC-B2.1 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.

L. Hydronic Fintube Radiation Control:

1. The hydronic fin 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 blank plate stainless steel sensor for each unit or groups of units in one room. Valve shall open/close to maintain space at 65°F, adjustable.

M. 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.
   a. On units equipped with direct connected outside air, provide a motor operated damper and actuator for the intake air hood or other opening as shown on the drawings.
   b. Whenever the system is activated and the indoor unit supply fan is running, outside air damper shall open fully. Damper shall close when the system is deactivated and the indoor unit supply fan stops.

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.
   c. Commanded status of outside air damper.

N.1 Kitchen D105 - Hood Exhaust Fan & Make-Up Air Unit Control:

1. This system consists of EF-D1, MAU-D1, and ventilator item 20 as shown on the drawings.
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 shown on the drawings.
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.
   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.
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.

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.

N.2 Pizza Oven Hood Exhaust Fan & Make-Up Air Unit Control: Kitchen D105

1. The sequence that follows is typical for two systems:

a. Middle School Servery includes EF-D2, MAU-D2, and ventilator item 33.

b. High School Servery includes EF-D4, MAU-D3, and ventilator item 33.

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 shown on the drawings.

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.

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.

6. Provide a current switch on one phase of power feeding the supply fan for monitoring and alarm generation at the OWS.

7. 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.
8. 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.
   f. Supply fan operational status via current switch.
   g. Exhaust fan operational status via current switch.
   h. Diagram showing the layout of the equipment with major components and dynamic temperatures shown where temperature sensors exist in the system.

N.3 Culinary Arts Kitchen Hood Exhaust Fan & Make-Up Air Unit Control:

1. The sequence that follows is typical for the following systems:
   a. Culinary Kitchen (1/2) includes:
      (1) EF-B4 and ventilator item K2.
      (2) EF-B5 and ventilator item K1.
      (3) MAU-B3 serves both ventilators.
   b. Culinary Kitchen (3/4) includes:
      (1) EF-B1, ventilator item C17, makeup air unit MAU-B1.
      (2) EF-B2, ventilator item C30, makeup air unit MAU-B2.
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 shown on the drawings.
   b. Units serving the Culinary Kitchen (1/2) shall operate in unison upon activation of either ventilator exhaust fan.
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.

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. Provide a motor operated damper and actuator for the branch exhaust air duct in the kitchen, as shown on the drawings. Whenever the hood exhaust fan is activated, the branch exhaust air damper shall close. Whenever the hood exhaust fan is shut down, the branch damper shall open.

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.

   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.

O.1 Exhaust Fan Control

1. The sequence that follows is typical for fans EF-B16, B17, B18, B19, and D8. Coordinate schedule with the zone rooftop unit serving the area where these fans are shown on the drawings.
2. 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.
3. 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.
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.

O.2 Dish Washer Exhaust Fan Control

1. The sequence that follows is typical for fans EF-B3 and EF-D3. 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.
2. 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.
3. Provide a current switch on one phase of power feeding the fan for status indication at the OWS.
4. 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.

O.3 Animal Lab Exhaust Fan Control

1. The animal lab is served by exhaust fan EF-B10. Provide motor operated damper and actuator as shown on the drawings.
2. Fan shall run continuously whenever the space is used to house animals. Damper shall remain open. Whenever fan shuts down, damper shall close.
3. Provide current switch to monitor fan operation.
   a. Interface with a common fire alarm input from the fire alarm system. When the fire alarm contact indicates an alarm condition, the BAS shall de-energize the fan. When de-energized, the damper motor shall spring air damper closed.
4. Provide the following indications to the system:
   a. fan status: on/off/alarm.
   b. commanded status of damper.

O.4 Bio/Anatomy Lab Exhaust Fan Control

1. The sequence that follows is typical for fans EF-B6, B7, B8, and B9.
2. Provide motor operated damper and actuator for each fan. Provide current switch to monitor fan

operation through one leg of power feeding the fan motor.

3. Provide motor operated damper and actuator for the branch exhaust air duct in each lab. This damper shall be normally open.
4. Fan shall be manually activated by a wall switch provided as part of the work of Division 26 – Electric. Whenever the switch is turned 'on', the fan exhaust damper shall open fully and subject to a limit switch in the actuator, fan shall start and run continuously. Exhaust damper in the branch exhaust air duct shall close.
   a. Interface with a common fire alarm input from the fire alarm system. When the fire alarm contact indicates an alarm condition, the BAS shall de-energize the fan. When de-energized, the damper motor shall spring air damper closed.
5. Upon deactivation of the exhaust fan, its damper shall close and room damper shall open.
6. Provide the following indications to the system:
   a. Fan status: on/off/alarm.
   b. Commanded status of fan exhaust air damper.
   c. Commanded status of branch exhaust air damper.

O.5 Fume Hood Exhaust Fan Control

1. The sequence that follows is typical for fans EF-B11, B12, and B13.
2. Provide actuator for isolation damper furnished with each fan.
3. Provide motor operated damper and actuator in the branch exhaust air duct serving the science room. Damper shall be normally open.
4. Division 26 – Electrical shall interface fan with manual on/off switch located on the face of each hood.
5. When switch is activated, exhaust damper shall open fully and subject to limit switch in the damper actuator, fan shall start and run continuously. Room exhaust air damper shall close.
6. Provide current switch on one leg of power feeding the fan motor for monitoring fan operation. Whenever fan fails to run once activated, initiate an alarm to the OWS. Calibrate switch between no load and full load amps to detect a broken drive belt.
7. Provide 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 run.
9. Provide fan status: on/off/alarm as an indication to the system.

O.6 Area H Laundry Ventilation Control

1. This system consists of a motor operated damper and actuator for control of outside air to support a commercial laundry dryer in the space.
2. Provide current switch on one leg of power to monitor operation of the laundry dryer.
3. Current switch shall activate the outside air damper whenever the dryer is turned 'on'. When the dryer cycles 'off', the damper shall close.

O.7 Area H Uniform Storage Ventilation Control

1. This system consists of exhaust fan EF-E1 (Base Bid) or EF-B3 (Alternate).
2. Provide motor operated dampers and actuators for control of exhaust air and outside air as shown on the drawings.

3. Provide room sensor to activate the system whenever the space temperature is at or above 80°F, adjustable. All dampers shall open fully, and exhaust fan shall run subject to a limit switch in the exhaust damper actuator.
4. Upon decrease in room temperature below setpoint, the reverse shall occur.
5. Interface with a common fire alarm input from the fire alarm system. When the fire alarm contact indicates an alarm condition, the BAS shall de-energize the fan. When de-energized, the damper motors shall spring all air dampers closed.
6. Provide room tempature and fan status: On/Off/Alarm as indications to the system.

O.8 Area H Team Storage Ventilation Control

1. This system consists of exhaust fan EF-E2 (Base Bid) or EF-E4 (Alternate).
2. Provide motor operated damper and actuator for control of exhaust air as shown on the drawings.
3. Provide room sensor to activate the system whenever the space temperature is at or above 80°F, adjustable. Exhausts air damper shall open fully, and exhaust fan shall run subject to a limit switch in the exhaust damper actuator.
4. Upon decrease in room temperature below setpoint, the reverse shall occur.
5. Interface with a common fire alarm input from the fire alarm system. When the fire alarm contact indicates an alarm condition, the BAS shall de-energize the fan. When de-energized, the damper motors shall spring all air dampers closed.
6. Provide room tempature and fan status: On/Off/Alarm as indications to the system.

P. Energy Recovery Unit Control

1. The following sequence is typical for eight units as scheduled on the drawings. Each unit consists of supply fan, exhaust fan, packaged DX cooling system with hot gas bypass controls, package indirect fired gas heating system, energy recovery wheel and drive, filters, air control dampers and actuators, drives for each fan, and unit controls.
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, outside air temperature sensor.
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 occupied/unoccupied schedule shall correspond to the occupancy schedule for the zone that is served by each unit. Delay startup of the unit until the zone temperature has recovered from its previous setback or setup temperature during the unoccupied mode.
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.
   a. When the unit is deactivated, the fans, heating and cooling shall be off and all dampers shall be closed.
6. 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.

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 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.

8. 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 7.

9. The following items shall be displayed at the OWS:

   a. Discharge air temperature.

   b. Discharge air temperature setpoint.

   c. Return air temperature.

   d. Exhaust air temperature.

   e. Fire alarm system status alarm.

   f. Commanded status of fans.

   g. Supply fan operational status via a current switch.

   h. Exhaust fan operational status via a current switch.

   i. Energy recovery wheel commanded status and alarm.

   j. Smoke detector status/alarm.

   k. Diagram showing the layout of the equipment with major components and dynamic temperatures shown where temperature sensors exist in the system.

Q.1 Packaged Rooftop Unit Control: General

1. The sequence that follows is typical for eight units as scheduled on the drawings. Each unit consists of a supply fan, packaged air-cooled DX cooling system, gas fired heating section, air filters, air control dampers and actuators, and unit controls.

   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, return air humidity sensor, global outside air temperature/humidity/enthalpy, CO2 sensors, and space temperature sensors. 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. Motor starters and 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. Discharge air temperature sensor.

c. Return air temperature and humidity sensors.

d. Global outside air temperature and humidity sensors.

e. Current sensor for one phase of the power feeding the fan.

f. Mixed air average temperature sensor.

g. CO2 sensors and space temperature sensors.

h. 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.

   a. Outside air damper shall remain closed until return air CO2 level rises to 700 ppm. The outside air damper shall step open from the closed 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 closed.

4. On a drop-in space air temperature below the programmed setpoint of 70°F, adjustable, the unit gas heating section shall be activated through its unit controls 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 hall be activated through its unit controls to maintain setpoint. On a fall in temperature the reverse shall occur. Maintain 75°F, adjustable.

6. 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 and humidity sensors to calculate outside air enthalpy. If the outside air enthalpy is at 25 BTU/lb, adjustable, the mixing box dampers shall modulate to maintain the mixed air temperature setpoint of 55°F, adjustable. The outside air damper shall continue to open up to 100% outside air to satisfy cooling demand. The return/relief dampers in the unit shall move in unison to maintain the balance of air in the unit. The outside air damper shall not close below the minimum position during the occupied period.

7. During the programmed un-occupied mode, the fan, heating, cooling and mixing box dampers shall be cycled/modulated 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 relief 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. 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.

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. The following items shall be displayed at the OWS:
    a. Average space temperature.
    b. Average space temperature setpoint.
    c. Mixed air temperature.
    d. Mixed air temperature setpoint.
    e. Global outside air temperature, humidity and enthalpy.
    f. Fire alarm system status/alarm.
    g. Duct smoke detectors status: normal/alarm.
    h. Commanded status of fan.
    i. Supply fan operational status via current switch.
    j. Diagram showing the layout of the equipment with major components and dynamic temperatures shown where temperature sensors exist in the system

Q.2 Rooftop Unit Control with Energy Recovery: RTU-E1

1. This unit is equipped with fans and drives, air-cooled DX system, gas-fired heating section, filters, an energy recovery module, and dampers for control of outside air, relief air, and bypass air. This unit shall operate as a constant volume system with 100% outside air.
    a. The unit shall be controlled by an individual DDC Controller.
    b. Wire the DDC Controller to the rooftop unit control section and to a space temperature sensor.
    c. The system shall maintain occupied/unoccupied periods according to its programmed schedule or as reset manually by the BAS.
2. During the unoccupied mode, the unit outside air and relief air dampers shall close, the bypass air damper shall open, the energy recovery module shall stop, and the fans shall stop. The system shall maintain its scheduled setup or setback temperatures. The system shall activate the rooftop unit supply fan and activate the gas-fired heating section or DX cooling section through its own controls. Once the zone sensor is satisfied, the unit shall shut down.
    a. During the programmed un-occupied mode, the 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 and relief air dampers shall remain closed with the bypass air damper fully open.
3. Prior to changeover to the occupied mode, the system shall activate the rooftop unit, start the supply fan, and stage the gas-fired heating section or DX cooling section through its own controls to restore the zone to heating setpoint of 70 °F, adjustable, or to cooling setpoint of 75°F, adjustable.
4. The outside 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 through unit controls 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.
   b. 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. 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.
7. 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 6.
8. The following items shall be displayed at the BAS:
   a. Discharge air temperature.
   b. Discharge air temperature setpoint.
   c. Return air and exhaust air temperatures.
   d. Fire alarm system status/alarm.
   e. Commanded status of fans.
   f. Supply fan operational status via current switch.
   g. Exhaust fan operational status via current switch.
   h. Energy recovery wheel commanded status and alarm.
   i. Smoke detector status/alarm.
   j. Diagram showing the layout of the equipment with major components and dynamic temperatures shown where temperature sensors exist in the system.

Q.3 Rooftop Unit Control

1. The sequence that follows is typical for systems RTU-B1/RF-B1, RTU-B2/RF-B2, and RTU-B3/RF-B3 as scheduled on the drawings. Each rooftop unit consists of a supply fan, packaged air-cooled DX cooling system, gas fired heating section, air filters, air control dampers and actuators, and unit controls with 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, return air humidity sensor, global outside air temperature/humidity/enthalpy, CO2 sensors, and space temperature sensors. The DDC Controller and all required sensors shall be provided by the BAS Contractor, field mounted and wired.
   c. Interlock each unit with its respective duct mounted return air fan.

2. The following items shall be provided by the equipment manufacturer:
   a. Motor starters and 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. Discharge air temperature sensor.
   c. Return air temperature and humidity sensors.
   d. Global outside air temperature and humidity sensors.
   e. Current sensor for one phase of the power feeding the fan.
   f. Mixed air average temperature sensor.
   g. CO2 sensors and space temperature sensors.
   h. 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.
   a. Outside air damper shall remain closed until return air CO2 level rises to 700 ppm. The outside air damper shall step open from the closed 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 closed.
4. On a drop-in space air temperature below the programmed setpoint of 70°F, adjustable, the unit gas heating section shall be activated through its unit controls 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 hall be activated through its unit controls to maintain setpoint. On a fall in temperature the reverse shall occur. Maintain 75°F, adjustable.
6. 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 and humidity sensors to calculate outside air enthalpy. If the outside air enthalpy is at 25 BTU/lb, adjustable, the mixing box dampers shall modulate to maintain the mixed air temperature setpoint of 55°F, adjustable. The outside air damper shall continue to open up to 100% outside air to satisfy cooling demand. The return/relief dampers in the unit shall move in unison to maintain the balance of air in the unit. The outside air damper shall not close below the minimum position during the occupied period.

7. During the programmed un-occupied mode, the fans, heating, cooling and mixing box dampers shall be cycled/modulated 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 relief 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 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.
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. The following items shall be displayed at the OWS:
    a. Average space temperature.
    b. Average space temperature setpoint.
    c. Mixed air temperature.
    d. Mixed air temperature setpoint.
    e. Global outside air temperature, humidity and enthalpy.
    f. Fire alarm system status/alarm.
    g. Duct smoke detectors status: normal/alarm.
    h. Commanded status of each fan.
    i. Supply fan operational status via current switch.
    j. Return fan operational status via current switch.
    k. Diagram showing the layout of the equipment with major components and dynamic temperatures shown where temperature sensors exist in the system

R. 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.

S. 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 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 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.

T. 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. 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 Operator Workstation 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.

U. Cold Storage Monitoring Control

1. Provide temperature sensor in each of the walk-in cold storage units in the culinary arts kitchens as shown on the food service drawings.
2. Set high limit alarms for each cold storage unit as recommended by the unit manufacturer.
3. Provide high limit alarms to the OWS and any remote call-out as directed by the Owner.

2.10 SEQUENCE OF OPERATION: MIDDLE SCHOOL WING

A. Host Computer and Operator's Work Station (OWS)

1. The host computer and accessories located in Room D113 shall include capacity for the work of this article.
2. Coordinate required capacity and features with the work of article 2.9.
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. Heating System Control:

1. This system consists of two boilers, B-A1 and B-A2, each with boiler circulating pumps P-A2 and P-A3, primary loop isolation valves, and building dual temperature heating/cooling pumps P-A4 and P-A5. 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 and sequencing panel will maintain setpoint of the system at the boiler's control panel.
2. Whenever the outdoor air temperature is at or below 55°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 'E', 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 secondary pump operation, and diagnostics. The BAS shall monitor boiler inlet/outlet, outside air temperature, modulation rate setpoint and mixing valve demand percent on the boiler's secondary heat exchanger.
4. When the boiler's integral controls are activated, its internal circulating pump and Pump P-A2 or P-A3 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 boiler/pump set to equalize the accumulated run time.
5. During the unoccupied mode of the building systems, the boilers shall maintain the following status:

Outdoor Temperature	Boiler Status
Less than 65°F	Hot Standby
Above 65°F	Off

   a. Whenever any space temperature sensor falls below 45°F, adjustable, during the unoccupied mode, the system shall activate the lead building dual temperature loop pump and lead boiler/boiler pump to provide heat until the setback space temperature is satisfied. If there is no call for heat after two hours (adjustable), the lead pumps and boiler shall be de-activated and return to the off or standby status as scheduled.
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. Primary Dual Temperature Heating/Cooling Water Pumps Control:

1. Pumps P-A4 and P-A5 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. The pumps shall also be subject to a manual command at the OWS. 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' where the branch piping connects to the main risers.

   c. The lead loop pump shall be enabled during the occupied mode, as programmed through the system. The loop pump VFD shall modulate the pump speed to maintain the differential pressure setpoint.

   d. Provide pressure actuated bypass valve at the pumps to maintain minimum flow to prevent the pumps from shutting off as the control valves on the room terminal units close. Set bypass flow equal to approximately 15% of total system flow. Locate bypass in the Room A301.

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 activated automatically according to the following schedule:

Outdoor Temperature	Occupied	Unoccupied
Less than 45°F	ON	ON
45°F to 65°F	ON	OFF

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-A4 Lead - Pump P-A5 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.

D. Chilled Water System Control:

1. This system consists of one air-cooled water chiller, CH-A1, dual temperature loop pumps P-A4 and P-A5, primary chiller pump P-A1, and interconnecting piping and accessories. Pumps P-A4 and P-A5 shall be controlled directly by the BAS per a lead/lag sequence as described in article C.
2. The chiller control sequence shall be activated on a rise in outside air temperature above the programmed setpoint of 70°F, adjustable. The chilled water system shall also be manually activated via a software switch at the OWS.
3. When the chiller control sequence is activated, the primary chilled water pump shall be energized. When water flow is proven 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. When building demand for cooling is satisfied, the BAS shall adjust the chiller setpoint upwards. The BAS shall provide an analog signal (0-10 vdc or 4-20 ma) to the chiller to reset the chiller discharge water temperature setpoint based on building demand.
5. 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.
6. The OWS shall accommodate up to 3 alarm/status inputs from the chiller for monitoring and alarm generation.
7. The BAS shall monitor chilled water discharge and return temperatures for display at the OWS.
8. BAS Contractor shall provide all field control wiring for operation of the chiller.
9. 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. Up to 3 alarm/status inputs for chiller.
   e. Chilled water discharge reset setpoint
   f. Chilled water pump start/stop command and status via current switch.
   g. Chilled water pump flow/alarm per pump via current switch.
   h. Chiller on/off command.
   i. Heat tape status.

E. 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.
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.

F. Domestic Water Heater System Control (Penthouse A301)

1. The domestic water heater located in the penthouse MER 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.

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.

G. Penthouse A301 Heating and Ventilation System Control

1. This system consists of unit heaters UH-A1 AND UH-A2, roof mounted exhaust fan EF-A1, and outside air intake IH-A3. 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.

H. Fan Coil Unit Control

1. Each unit shall be controlled by an individual DDC Controller. 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 flat plate space sensors for units that serve stairways, as well as corridors; no override switch is required in these locations.

2. During the programmed occupied mode, the fan shall run continuously.
   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, 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. Diagram showing the layout of the unit with major components and dynamic temperatures shown where temperature sensors exist in the system.

I. 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 un-occupied mode, the fan shall cycle and the hot water coil control valve 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. 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.

K. Zone Heating Duct Coil Control

1. Duct coils, DC-A1.1 through DC-A1.17, and DC-A2.1 through DC-A2.3, 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.

L. Hydronic Fintube Radiation Control:
1. The hydronic fin 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 blank plate stainless steel sensor for each unit or groups of units in one room. Valve shall open/close to maintain space at 65°F, adjustable.

M. Ductless Split System Unit Control:
1. The following sequence is typical for all units as 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.
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.

N.1 Exhaust Fan Control:
1. The sequence that follows is typical for fans EF-A2, A3, A4, and A5. Coordinate schedule with the zone rooftop unit serving the area where these fans are shown on the drawings.
2. 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.
3. 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.
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.

N.2 Exhaust Fan Control: EF-C1 STAGE EFFECTS

1. This 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. The damper shall be installed by the Mechanical Contractor.
3. Once activated by the switch, and subject to a limit switch on the exhaust air damper, the fan shall run continuously.
4. Provide a current switch on one phase of power feeding the fan for status indication at the OWS.
5. 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 de-energize the fan and close the exhaust air damper.
6. The following items shall be displayed at the OWS:
   a. Fan status via current switch: on/off/alarm.

O. Energy Recovery Unit Control

1. The following sequence is typical for six units as scheduled on the drawings. Each unit consists of supply fan, exhaust fan, packaged DX cooling system with hot gas bypass controls, package indirect fired gas heating system, energy recovery wheel and drive, filters, air control dampers and actuators, drives for each fan, and unit controls.
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, outside air temperature sensor.
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 occupied/unoccupied schedule shall correspond to the occupancy schedule for the zone that is served by each unit. Delay startup of the unit until the zone temperature has recovered from its previous setback or setup temperature during the unoccupied mode.
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.
   a. When the unit is deactivated, the fans, heating and cooling shall be off and all dampers shall be closed.
6. 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.
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 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.

8. 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 7.
9. The following items shall be displayed at the OWS:
   a. Discharge air temperature.
   b. Discharge air temperature setpoint.
   c. Return air temperature.
   d. Exhaust air temperature.
   e. Fire alarm system status alarm.
   f. Commanded status of fans.
   g. Supply fan operational status via a current switch.
   h. Exhaust fan operational status via a current switch.
   i. Energy recovery wheel commanded status and alarm.
   j. Smoke detector status/alarm.
   k. Diagram showing the layout of the equipment with major components and dynamic temperatures shown where temperature sensors exist in the system.

P.1 Packaged Rooftop Unit Control

1. The sequence that follows is typical for units RTU-A1 and C3, as scheduled on the drawings. Each unit consists of a supply fan, packaged air-cooled DX cooling system, gas fired heating section, air filters, air control dampers and actuators, and unit controls.
   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, return air humidity sensor, global outside air temperature/humidity/enthalpy, CO2 sensors, and space temperature sensors. 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. Motor starters and 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. Discharge air temperature sensor.
c. Return air temperature and humidity sensors.
d. Global outside air temperature and humidity sensors.
e. Current sensor for one phase of the power feeding the fan.
f. Mixed air average temperature sensor.
g. CO2 sensors and space temperature sensors.
h. 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.
   a. Outside air damper shall remain closed until return air CO2 level rises to 700 ppm. The outside air damper shall step open from the closed 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 closed.
4. On a drop-in space air temperature below the programmed setpoint of 70°F, adjustable, the unit gas heating section shall be activated through its unit controls 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 hall be activated through its unit controls to maintain setpoint. On a fall in temperature the reverse shall occur. Maintain 75°F, adjustable.
6. 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 and humidity sensors to calculate outside air enthalpy. If the outside air enthalpy is at 25 BTU/lb, adjustable, the mixing box dampers shall modulate to maintain the mixed air temperature setpoint of 55°F, adjustable. The outside air damper shall continue to open up to 100% outside air to satisfy cooling demand. The return/relief dampers in the unit shall move in unison to maintain the balance of air in the unit. The outside air damper shall not close below the minimum position during the occupied period.
7. During the programmed un-occupied mode, the fan, heating, cooling and mixing box dampers shall be cycled/modulated 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 relief 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. 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.

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 toitem 8.
10. The following items shall be displayed at the OWS:
    a. Average space temperature.
    b. Average space temperature setpoint.
    c. Mixed air temperature.
    d. Mixed air temperature setpoint.
    e. Global outside air temperature, humidity and enthalpy.
    f. Fire alarm system status/alarm.
    g. Duct smoke detectors status: normal/alarm.
    h. Commanded status of fan.
    i. Supply fan operational status via current switch.
    j. Diagram showing the layout of the equipment with major components and dynamic temperatures shown where temperature sensors exist in the system.

P.2 Rooftop Unit Control with Energy Recovery: RTU-A2

1. This unit is equipped with fans and drives, air-cooled DX system, gas-fired heating section, filters, an energy recovery module, and dampers for control of outside air, relief air, and bypass air. This unit shall operate as a constant volume system with 100% outside air.
    a. The unit shall be controlled by an individual DDC Controller.
    b. Wire the DDC Controller to the rooftop unit control section and to a space temperature sensor.
    c. The system shall maintain occupied/unoccupied periods according to its programmed schedule or as reset manually by the BAS.
2. During the unoccupied mode, the unit outside air and relief air dampers shall close, the bypass air damper shall open, the energy recovery module shall stop, and the fans shall stop. The system shall maintain its scheduled setup or setback temperatures. The system shall activate the rooftop unit supply fan and activate the gas-fired heating section or DX cooling section through its own controls. Once the zone sensor is satisfied, the unit shall shut down.
    a. During the programmed un-occupied mode, the 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 and relief air dampers shall remain closed with the bypass air damper fully open.
3. Prior to changeover to the occupied mode, the system shall activate the rooftop unit, start the supply fan, and stage the gas-fired heating section or DX cooling section through its own controls to restore the zone to heating setpoint of 70 °F, adjustable, or to cooling setpoint of 75°F, adjustable.
4. The outside 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 through unit controls 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.

b. 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. 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.
7. 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 6.
8. The following items shall be displayed at the BAS:
   a. Discharge air temperature.
   b. Discharge air temperature setpoint.
   c. Return air and exhaust air temperatures.
   d. Fire alarm system status/alarm.
   e. Commanded status of fans.
   f. Supply fan operational status via current switch.
   g. Exhaust fan operational status via current switch.
   h. Energy recovery wheel commanded status and alarm.
   i. Smoke detector status/alarm.
   j. Diagram showing the layout of the equipment with major components and dynamic temperatures shown where temperature sensors exist in the system.

P.3 Rooftop Unit Control

1. The sequence that follows is typical for systems RTU-A3/RF-A1, RTU-C2/RF-C1, and RTU-C3/RF-C2 as scheduled on the drawings. Each rooftop unit consists of a supply fan, packaged air-cooled DX cooling system, gas fired heating section, air filters, air control dampers and actuators, and unit controls with 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, return air humidity sensor, global outside air temperature/humidity/enthalpy, CO2 sensors, and space temperature sensors. The DDC Controller and all required sensors shall be provided by the BAS Contractor, field mounted and wired.
   c. Interlock each unit with its respective duct mounted return air fan.
2. The following items shall be provided by the equipment manufacturer:
   a. Motor starters and 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. Discharge air temperature sensor.

c. Return air temperature and humidity sensors.

d. Global outside air temperature and humidity sensors.

e. Current sensor for one phase of the power feeding the fan.

f. Mixed air average temperature sensor.

g. CO2 sensors and space temperature sensors.

h. 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.

   a. Outside air damper shall remain closed until return air CO2 level rises to 700 ppm. The outside air damper shall step open from the closed 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 closed.

4. On a drop-in space air temperature below the programmed setpoint of 70°F, adjustable, the unit gas heating section shall be activated through its unit controls 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 hall be activated through its unit controls to maintain setpoint. On a fall in temperature the reverse shall occur. Maintain 75°F, adjustable.

6. 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 and humidity sensors to calculate outside air enthalpy. If the outside air enthalpy is at 25 BTU/lb, adjustable, the mixing box dampers shall modulate to maintain the mixed air temperature setpoint of 55°F, adjustable. The outside air damper shall continue to open up to 100% outside air to satisfy cooling demand. The return/relief dampers in the unit shall move in unison to maintain the balance of air in the unit. The outside air damper shall not close below the minimum position during the occupied period.

7. During the programmed un-occupied mode, the fans, heating, cooling and mixing box dampers shall be cycled/modulated 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 relief 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 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.

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. The following items shall be displayed at the OWS:
    a. Average space temperature.
    b. Average space temperature setpoint.
    c. Mixed air temperature.
    d. Mixed air temperature setpoint.
    e. Global outside air temperature, humidity and enthalpy.
    f. Fire alarm system status/alarm.
    g. Duct smoke detectors status: normal/alarm.
    h. Commanded status of each fan.
    i. Supply fan operational status via current switch.
    j. Return fan operational status via current switch.
    k. Diagram showing the layout of the equipment with major components and dynamic temperatures shown where temperature sensors exist in the system

Q. 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.

R. 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 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 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.

S. 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. 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 Operator Workstation 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.

2.11 SEQUENCE OF OPERATION: Field House

A. Building Network Panel

1. The building network control panel shall be located in the Trainer's Office, Room FH45, as shown on the drawings, or as directed by the Owner. The system shall be capable of remote monitoring from the OWS in Room D113. 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. Packaged Terminal Heat Pump Unit Control:

1. Each of three units is equipped with a factory furnished, wall mounted programmable thermostat. Interface thermostat with each unit as shown on the drawings.
2. Set unit thermostat to maintain schedule and setpoints as directed by Owner's representative.

C. 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-1 with GFH-1.

b. Interlock EF-2 with GFH-2.

c. Interlock EF-4 with GF-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.

D. Gas Fired Heater/Blower Unit Control

1. Provide a wall mounted temperature sensor and guard as shown on the drawings; interface with factory controls as shown on the drawings.

2. Provide motor operated damper and actuator for control of outside air at the intake louver.

3. Provide motor operated dampers and actuators for control of return air at the unit.

4. During the occupied mode, sensor shall open outside air damper fully, return air dampers shall remain 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.

5. During the unoccupied mode, outside air damper shall remain closed and the return air dampers at the unit shall remain fully open. Sensor shall activate the unit fan and gas heating section to maintain space temperature at 55°F, adjustable.

6. 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

E. Split System Gas Furnace Unit Control:

1. The system GF-1/ACC-1 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 programmable thermostat, which is furnished by the equipment manufacturer, and interlock the controls from the indoor unit to the outdoor unit. Provide guard on thermostat.

2. Provide motor operated dampers and actuators for control of outside air and return air at the unit.

3. During the occupied mode, thermostat shall open outside air damper to its minimum position, return air damper shall move to maintain the balance of air in the system.

a. Thermostat shall 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 all air dampers shall close.

b. On a rise in space temperature above setpoint, the thermostat shall activate DX system controls, start unit fan to maintain space temperature at 75°F, adjustable. De-energize fan once setpoint is achieved and close all dampers.

4. During the unoccupied mode, outside air damper shall remain closed and the return air damper at the unit shall remain fully open. Thermostat shall activate the unit fan and gas heating section to maintain space temperature at 55°F, adjustable. System shall remain off during the cooling season.
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

F. Electric Heater Control:
1. Provide control voltage relay for each unit for activation through the OWS based on the owner's occupancy schedule.
2. Provide wall mounted temperature sensor with guard for each cabinet heater, ECH-1 and -2, and unit heater, EUH-1. Set to maintain 65°F during the occupied mode and 55°F during the unoccupied mode.
3. Set unit thermostat on the wall heaters, EWH-1 to EWH-4, to maintain 65°F when activated by the OWS.
4. Provide space temperature and unit status as indications to the system.

G. Utility Room FH49 Ventilation System Control
1. This system consists of exhaust fan EF-3 and an outside air intake louver. Provide motor operated dampers and actuators for control of exhaust and outside air in the room. Provide space temperature sensor with guard 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. The following items shall be displayed at the OWS:
   a. Space temperature.
   b. High temperature alarm, 100°F, adjustable.
   c. Ventilation setpoint.
   d. Commanded status of exhaust fan and dampers.

H. 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: Maintenance Building

A. Building Network Panel
1. The building network control panel shall be located in the Office, Room 104, as shown on the drawings, or as directed by the Owner. The system shall be capable of remote monitoring from the OWS in Room D113. 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 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. Packaged Terminal Heat Pump Unit Control:

1. The unit is equipped with a factory furnished, wall mounted programmable thermostat. Interface thermostat with unit as shown on the drawings.
2. Set unit thermostat to maintain schedule and setpoints as directed by Owner's representative.

C. Electric Wall Heater Control

1. The heater is furnished with a unit-mounted thermostat.
2. Set thermostat to maintain 65°F, adjustable.
3. Provide control voltage relay for the 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. Interface exhaust fan EF-2 with room occupancy sensor.
2. Provide motor operated damper and actuator for control of exhaust air.
3. Sensor shall open damper fully and activate fan to run continuously whenever room is in use.

E. Gas Unit Heater Control

1. Each unit is furnished with a wall mounted thermostat and guard.
2. Provide control wiring between each unit and its thermostat.
3. Set thermostat to maintain 65°F, adjustable.

F. Vehicle Bay Ventilation Control

1. This system consists of exhaust fan EF-1 and outside air intake louver with damper.
2. Provide manual wall switch to activate the system, motor operated dampers and actuators for control of outside air at the louver, and exhaust air at the roof fan.
3. Upon manual activation at the switch, air dampers shall open fully and fan shall run continuously. When deactivated, fan shall stop and all dampers shall close.

G. 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.

2.13 SEQUENCE OF OPERATION: Greenhouse/Headhouse Building

A. Building Network Panel

1. The building network control panel shall be located in the Sales Office, Room GH102, as shown on the drawings, or as directed by the Owner. The system shall be capable of remote monitoring from the OWS in Room D113. 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 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 gas furnace GF-1 and remote condenser ACC-1.
   a. The furnace is furnished with a programmable wall mounted thermostat. Mount and wire the thermostat to the furnace and condensing unit per manufacturer's instructions.
   b. Provide motor operated dampers and actuators for control of outside air and return air at the furnace as shown on the drawings.
2. During the occupied mode, thermostat shall open outside air damper and return air damper to maintain the balance of air in the unit. Thermostat shall start unit fan and activate unit gas controls or cooling components 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 all air dampers shall close.
3. During the unoccupied mode, outside air damper shall remain closed and the return air damper at the unit shall remain fully open. 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 and return air dampers.

C.1 Electric Wall Heater Control

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.

C.2 Electric Cabinet Heater Control:

1. Provide control voltage relay for activation through the OWS based on the owner's occupancy schedule.
2. Provide wall mounted temperature sensor with guard for cabinet heater, ECH-1. Set to maintain 65°F during the occupied mode and 55°F during the unoccupied mode.

3. Provide space temperature and unit status as indications to the system.

D. Headhouse Exhaust Fan Control

1. Provide motor operated damper and actuator for control of exhaust air at the roof.
2. During the unoccupied mode, damper shall remain closed and fan EF-1 shall be off.
3. During the occupied mode specified for the gas furnace unit, damper shall open fully and fan shall run continuously subject to limit switch on the damper actuator.
4. Provide the following indications to the system:
   a. Commanded status of fan through current switch.
   b. Commanded status of exhaust air damper.

E. Fire Alarm System Interface

1. FAS devices such as fire, smoke, and CO 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.

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 for each building 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 23 0900

SECTION 23 0950
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 cooperate with the Construction Manager and the Mechanical Contractor to effect smooth coordination of the balancing work with the job schedule.

G. 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.

H. 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, and chilled 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 230950

SECTION 26 0000
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 0055
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 0110
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. <u>Rigid Metal Conduit</u>:

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

   Carlon

   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 0120
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. <u>Wire and Cable</u>

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 0130
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 26 0130

SECTION 26 0135
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 26 0135

SECTION 26 0140
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 unless otherwise indicated. Hubbell Cat. #HBL5362 or approved substitute, HBL5362TR where tamperproof is indicated.

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 signalling, 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.

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 earls, 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 pr block walls, Provide 4” square boxes, surface mounted, with ½” 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 2o 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 26 0140

SECTION 26 0155
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 26 0155

SECTION 26 0156
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 26 0156

SECTION 26 0160
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 0165
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 meduim 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 ampers. 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.

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 26 0165

SECTION 260170
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 26 0170

SECTION 26 0180
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. <u>Circuit-Breakers</u>

   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 26 0180

SECTION 26 0190
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 Huffel 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 insure 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 26 0190

SECTION 26 0195
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 <u>all</u> downstream distribution and branch panelboards; and from generator to <u>all</u> 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 26 0195

SECTION 26 0430
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 26 0430

SECTION 26 0444
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-Cyclle 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 26 0444

SECTION 260452
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 26 0452

SECTION 26 0460
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):

Pad Mounted	Dry
Cooper	General Electric
The ABB Group	Sorgel Electric Division/Square D Company
Approved Substitute	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.

C. Pad-Mounted Transformers:

1. The transformer shall be compartmental type, self-cooled, tamper-proof and weatherproof for mounting on a pad and shall comply with latest applicable standards of the National Electrical Manufacturers Association (NEMA) and the American National Standards Institute (ANSI). There shall be no exposed screws, bolts, or other fastening devices which are externally removable.
2. The transformer shall be of the sealed tank construction of sufficient strength to withstand a pressure of 7 psi without permanent distortion. The cover shall be welded and the fastenings tamperproof. The transformer shall remain effectively sealed for a top oil temperature range of 50 deg. C to 106 deg. C. When required, cooling panels will be provided on the back and sides of the tank. Lifting eyes and jack pads shall be provided.
3. The core and coil assembly shall be wound core type with aluminum windings. A tap changing mechanism shall be provided for deenergized operation only and externally operable with two 2-1/2% full capacity taps above and two 2-1/2% full capacity taps below normal rated primary voltage.
4. Refer to Single-Line Diagram for details.
5. The high and low voltage compartment shall be located side-by-side separated by a steel barrier. When facing the transformer, the low voltage compartment shall be on the right. Terminal compartment shall be full height, air filled with individual doors. The high voltage door fastenings shall not be accessible until low voltage door has been opened. The low voltage door shall have a 3-point latching mechanism with vault type handle having provisions for a single padlock. The doors shall be equipped with lift-off type stainless steel hinges and door stops to hold the doors open when working in the compartments. The front sill of the compartment shall be removable to allow the transformer to be rolled or skidded into position over conduit stubs. ANSI tank grounding provisions shall be furnished in each compartment.
6. The high voltage terminations and equipment shall be dead front and conform to ANSI C57.12.26 requirements. The dead front bushings wells shall have feed-thru inserts designed for use with elbow type terminators and elbow type surge arresters, for operation with distribution hot stick.
   a. Elbow type terminators: Furnish a one piece, three-phase, non-skirted, shielded, loadbreak elbow type rubber termination, classified as ANSI/IEEE Standard 386 "200 AMP loadbreak Interface No. 1", 14.4/24.94 KV, with the following characteristics:

(1) Standard voltage class	25KV
(2) Maximum rating phase to phase	26.3KV
(3) Maximum rating phase to ground	15.2KV
(4) AC 60 Hz. 1 minute withstand	40KV
(5) DC 15-min. withstand	78KV
(6) Bil and full wave crest	125KV
(7) Min. corona voltage level	19KV

   b. Elbow type surge arresters: Shall combine metal oxide varistor technology in a premolded rubber elbow to provide overvoltage system protection in an insulated fully shielded, deadfront device, with the following characteristics:

(1) Standard voltage class	25KV
(2) Max. operating voltage	18.6KV
(3) Equiv. front of wave voltage	67.5KW

(4) Discharge voltage -	1.5KA	60.0KV
	5KA	70.0KV
	10KA	78.0KV
	20KA	86.0KV
(5) MCOV Rating		18.6KV

Surge arrester shall be designed for use with RTE 200 A loadbreak bushings, similar to RTE components.

7. The low voltage bushings shall be molded epoxy and provided with blade type spade terminals with NEMA standard hole spacing arranged for vertical take-off. The low voltage neutral shall be an insulated bushing grounded to the transformer tank by a removable ground strap.
8. Furnish the following accessories:
   a. Nameplate in low voltage compartment.
   b. One-inch drain valve with sampling device.
   c. Dial type thermometer.
   d. Liquid level gauge.
   e. Pressure-vacuum gauge.
   f. Pressure relief device (self-resealing with indicator).

2.3 HARMONIC MITIGATING ISOLATION TRANSFORMERS:

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.

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-1/2/3 as indicated on single line diagram 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 26 0460

SECTION 26 0470
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.

END OF SECTION 26 0470

SECTION 26 0471
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.

END OF SECTION 26 0471

SECTION 260472
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 may elect to use metal clad cable in lieu of electrical metallic tubing (EMT) in wall cavities, and/or above tile or dry wall ceilings. In all areas of exposed construction, electrical metallic tubing (EMT) shall be installed.

END OF SECTION 26 0472

SECTION 26 0475
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 26 0475

SECTION 26 0510
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 0520
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 26 0520

SECTION 26 0601
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 26 0601

SECTION 26 0606
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 0612
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, dripproof 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 "Fload-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" H/2/0 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 0660

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 red service LED.
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 red service LED.

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 0731
WIRELESS CLOCK SYSTEM

PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS & SCOPE

A. The System is specified as described

1. Furnish and install a complete new Wireless Clock System using the Primex OneVue™ platform.
2. Furnish and install all system devices, accessories, and materials in accordance with these specifications and drawings to provide a complete and operating Wireless Clock System.
3. All bids shall be based on the equipment as specified herein. The model designations are that of Primex. The specifying authority must approve any alternate Wireless Clock System.
4. System shall include the System Devices below:

   Bridge with Ethernet/Power over Ethernet (PoE) and Bluetooth® low energy wireless technology

   Analog Clocks with Bluetooth® low energy wireless technology

1.2 RELATED SECTIONS

A. Division 26 “Electrical”

1.3 REFERENCES

A. System devices specified shall meet or exceed the requirements of the following:

1. Federal Communications Division (FCC); Part 15 - Code of Federal Regulations.
2. National Fire Protection Association (NFPA); NFPA 70E-[2012], Standard for Electrical safety in the Workplace.
3. Institute of Electrical and Electronics Engineers (IEEE); IEEE 802.3af-[1998], Standard for Information Technology - Telecommunications and Information Exchange Between Systems.
4. Bluetooth® wireless technology standard 4.1

1.4 DEFINITIONS

A. This section provides commonly used terms within this specification.

1. TSA:Technical Support Agreement
2. AWS: Amazon Web Services
3. TLS: Transport Layer Security
4. HTTPS: Hypertext Transfer Protocol Secure
5. Bluetooth® low energy - a wireless technology protocol which can be used for communication between embedded devices and smart devices.
6. SNTP – Simple Network Time Protocol.
7. PoE - Power over Ethernet

1.5 SYSTEM DESCRIPTION

A. General Specifications

1. System shall provide synchronized time by way of system devices and a cloud-based system software, hosted by the Manufacturer, that allows Owner to manage and monitor system devices.

2. System can be scaled from a single building to a network of buildings, or an enterprise spread across many time zones, providing traceable of accuracy, data and performance.
3. System shall consist of system clock devices enabled with Bluetooth low energy wireless technology.
4. System Bluetooth clocks shall not be required to have a direct connection to the Owner's existing Power over Ethernet (PoE) or 802.11 wireless network.
5. System devices enabled with 802.11, Power over Ethernet (PoE) technology shall be required to have a direct connection to the Owner's existing network.
6. System Bluetooth clocks shall form a system Bluetooth wireless network by way of the proprietary Bluetooth Network Protocol designed and developed by the Manufacturer, that allows system Bluetooth clocks to form a Bluetooth wireless technology network to allow a communication path to send clock data to the system Bridge devices.
7. System Bridge(s) shall receive data from system Bluetooth clocks and send the data to the system software. Bridge shall download settings from the system software and send settings to the system Bluetooth clocks.
8. System shall not require the installation of any on-site system hardware or software, with the exception of the specified system devices.

B. System Software specifications

1. System software shall be accessed from a web browser and does not require the installation of software or other third-party plug-ins or applications.
2. System users shall be able to access the system software from a web browser on a mobile or tablet device or computer with an internet connection.
3. System software shall provide an online device configuration procedure that allows Owner supplied settings to be installed on system 802.11 Wi-Fi or Non-DHCP network devices prior to shipment from the Manufacturer.
4. System software shall log NTP accuracy.
5. System software shall monitor and display the operating status of system devices.
6. System software shall provide an automated reporting method to notify system users of the operating status of system devices that may warrant corrective action.
7. System software shall allow authorized system users to create reports, view archived reports, and set the system to automate report notifications sent to system users.
8. System software shall maintain and store remote, redundant data backups.

C. System Bluetooth wireless network specifications

1. System Bluetooth wireless network shall be able to adjust and synchronize system Bluetooth clocks to specified Time Zone Offset and DST rules; time zone settings are managed within the system software and sent to the system Bluetooth clocks over the system Bluetooth wireless network.
2. System Bluetooth wireless network protocol shall form a tree-type topology; where clock data transfer is up or down in a tree structure topology; a path with highest Bluetooth Wireless Signal level quality is chosen at any time.
3. System Bluetooth wireless network shall have the capability to distinguish the system Bluetooth devices with Bluetooth wireless technology by the system devices' unique Device ID and/or Network ID; allowing only system Bluetooth devices to authenticate to the system Bluetooth wireless network.

4. At a system set daily time interval, the system Bluetooth clocks shall advertise their Bluetooth signal to form a system Bluetooth wireless network.
5. System Bluetooth wireless network shall be self-forming, self-healing, and self-organizing.
    a. Self-healing: in the event of a system Bluetooth clock hardware failure or loss of Bluetooth wireless signal, a connection previously handled by it is rerouted to another clock within the system Bluetooth wireless network.
    b. Self-forming: a system Bluetooth wireless network is automatically formed once daily at a system set time to allow system Bluetooth clocks to advertise their status to form the system Bluetooth wireless network.
    c. Self-organizing: the System Bluetooth wireless network protocol automatically connects system Bluetooth clocks, that are within Bluetooth wireless range, to form a data transmission path within the system Bluetooth wireless network.

D. Bridge specifications

1. Bridge shall be equipped with Bluetooth enabled gateway; which allows the device to send and receive communication to and from system Bluetooth clocks.
2. Bridge devices shall connect to the Owner's existing wired Ethernet, PoE, or 802.11 wireless network to send its device data and system Bluetooth clock data to the system software and download its device settings and clock settings from the system software.
3. Bridge shall send settings to system Bluetooth clocks within the system Bluetooth wireless network. Each system Bluetooth clock is identified by a unique Device ID allowing each clock to receive its unique Device ID settings. Device ID settings shall be managed in the system software. Bluetooth Analog Clock Device ID settings include its Time Zone Offset setting and DST rules. Bluetooth Digital Clock/Timer Device ID settings include its Time Zone Offset setting and DST rules and display settings.
4. Bridge shall listen and receive system Bluetooth clock data advertised in the system Bluetooth wireless network. During its 8-hour deployment mode, a Bridge shall send a new Bluetooth clock Device IDs to the system software within 30 minutes of receiving it. If not in 8-hour deployment mode, new Bluetooth clock data is sent the system software within 24 hours.
5. Bridge shall obtain Coordinated Universal Time (UTC) derived from a Network Time Protocol (NTP) Server (either internal or external); up to three designated NTP Servers may be specified to ensure continuity of time synchronization. The Bridge shall send obtained UTC time received from its NTP Server to the system Bluetooth clocks and the clocks shall synchronize the received UTC time to their Time Zone Offset setting and DST rules.
6. Bridge devices shall be primarily powered by Power over Ethernet. Battery-power shall be used only as a backup power source for a relatively short period of time.
7. Bridge devices that connect to a Wi-Fi or Non-DHCP network can be preconfigured by the Manufacturer with Owner provided settings before shipment to Owner facility or configured locally at the device by the Owner on-site.
8. Bridge devices shall have a LCD screen that displays connection status, and indicate when in an error or alarm state.
9. Bridge devices shall have LED indicators, located on the front of the device, that provide a visual indicator of its current status and operating state.
10. Bridge device shall have the ability to store configuration data for up to 1400 Bluetooth clocks in its local device memory; to avoid loss of data if a network connectivity issue prevents data to be sent to the system software.

11. Check-in interval setting shall be set by the system. Check-in Interval is the frequency the Bridge device is scheduled establish a network connection to Owners network to send data to and download data from the system software.
12. Unresponsive timeout setting shall be set by the system. Unresponsive timeout is defined as the amount of time a device can go without a connection to the system software; when this time is exceeded, the system sets the device to a warning state.

E. System Clocks enabled with Bluetooth® low energy wireless technology specifications (System Bluetooth clocks)

1. Clocks shall not require manual or direct configuration by an end user to establish a connection to a system Bluetooth wireless network, nor does an end user need to know about the intricacies of Bluetooth networking. The entire Bluetooth network infrastructure is transparent to the end user.
2. Clocks shall be equipped with a Bluetooth low energy wireless technology radio component; that allows system Bluetooth clocks to establish wireless Bluetooth connections to form a system Bluetooth wireless network. Each clock shall be a node within the system Bluetooth wireless network.
3. Clocks shall form a wireless connection and communication path by way of the proprietary system Bluetooth Wireless Networking protocol designed and developed by the Manufacturer.
4. Clocks shall wake-up once a day, at a system defined time, to form and build a system Bluetooth wireless network; allowing each system clock to send and/or forward its status data to the Bridge and receive setting updates sent by the Bridge. Each clock connects to another clock based on the strongest Bluetooth signal. The Bridge stores and sends clock status data to the system software once a day. When a bridge is in a 8-hour deployment mode, clock data is sent every 30 minutes to the system software.
5. Upon first-power up at its installation location, a new system Bluetooth clock shall go through a self-discovery initiation process; the clock shall continuously search for a system clock to receive its time and daily connection schedule.
6. Clocks shall not be required to be in plain line of sight or directly connected to a system Bridge device and shall act as independent nodes within the system Bluetooth wireless network.
7. If a clock's Bluetooth wireless signal connection is interrupted or down, the other clocks within the Bluetooth wireless range shall be able to transmit data to the system Bridge device through other Bluetooth clocks within the system Bluetooth wireless network. Clock data moves through the system Bluetooth wireless network communication path until the data reaches a system Bridge device.
8. Clocks shall be available, at predefined time intervals set by the system, to connect to new Bluetooth clocks that are attempting to connect to the system Bluetooth wireless network; allowing new clocks to receive and synchronize their time from an existing system Bluetooth clock.
9. Clock device firmware shall perform diagnostics on battery life, time accuracy, and connection strength. The Bridge devices shall transmit the clock diagnostic data to the system software.
10. Clocks shall operate with a free running accuracy of .45 seconds per day, and will continue to operate in the absence of receiving the broadcasted UTC time from the Bridge.
11. Clocks shall be fully portable, capable of being relocated at any time.

12. Analog clocks shall report gross mechanical failures by way of automatically performing a daily midnight hand verification check; which if this check shall fail for three consecutive days, the clock shall report a hand position failure status, resulting in a clock warning state within the system software.

F. Encryption and Authentication specifications

1. User software access sessions between the web browser and the system software shall be encrypted by the HTTPS protocol.
2. The network communication of system devices enabled with 802.11, Ethernet, or PoE Technology shall be secure and encrypted using the Transport Layer Security (TLS) encryption protocol and Secure Hypertext Transfer Protocol (HTTPS) authentication.

G. System Administration specifications

1. Software interface shall allow the Owner's system admin user(s) to manage the system components, including: system device settings, reports, system-wide user password complexity settings and user session timeout setting to align with Owner information security policies and procedures, manage system users and grant user access to system data and features, activate and deactivate system users, and view user log in history.
2. System software shall allow each system user to manage their own system profile, including their log in email address, password, and contact settings.
3. System software shall allow system device settings to be user-defined to meet Owner requirements.
4. System software shall allow devices that use a 802.11 or Non-DHCP network connection to be assigned to a primary and alternate network for failover purposes. Network settings are managed within the system software, allowing remote management to migrate devices from one network to another.
5. System software shall allow user-defined reporting; system shall store and present system historical data in the form of system reports. User-defined data shall include the system devices included in a report, the frequency a report is system generated, and a specific range of data included in a report. System reports shall be displayed in the system software electronically within the interface allow a system user to print and download reports. System shall allow report data to be restricted based on the role(s) assigned to a system user profile.

H. System devices with 802.11 Wi-Fi or Non-DCHP network communication specifications

1. Network Communication: Wireless Networking Protocols: 802.11b, 11g, single stream 11n*, 2.4 Ghz | Security Protocols: WPA, WPA2 (AES and TKIP) | Encryption Protocols: TLS 1.2 | Network Communication Protocols: Hypertext Transfer Protocol Secure (HTTPS) | IP Addressing: Dynamic Host Configuration Protocol (DHCP), static IP addressing | Data Packet Size: typically less than 5 kilobytes (kB)
2. Network setting data is stored locally in devices shall be encrypted and access to locally stored setting data can be controlled by a system admin user.
3. Manufacturer shall provide stand-alone configuration software to locally configure a device to meet Owner security policies if network setting data cannot be stored in third-party software or to troubleshoot device network connectivity issues.

1.6 REGULATORY REQUIREMENTS

A. Equipment and components furnished shall be of the Manufacturer latest model.

B. System devices shall be installed in compliance with local and state authorities having jurisdiction.

C. Electrical Components, Devices, and Accessories: Listed and labeled per NFPA 70 by qualified testing agency.

D. Regulatory Requirements: System design and installation shall comply with the following: National Electric Code (NEC)

1. Underwriters Laboratory (UL) standards
2. Local codes and regulations

1.7 SUBMITTALS

A. Product Data: Submit complete catalog data for each system device and components, describing physical characteristics and method of installation.

B. Shop Drawings: Showing the following. 1. Diagram of proposed system showing communication pathway and schedule of individual system device installation locations. 2. Indicate integration with the Owner's network. Include a line diagram of network relationships. 3. Show system device power requirements.

C. Samples: Submit one specified system device model(s) for approval. Approved sample(s) shall be tagged and shall be installed at location directed.

D. Manufacturer Instructions: Submit complete installation, set-up and maintenance instructions electronically.

E. Information submittal: Manufacturer Sample Warranty

F. Information submittal: Manufacturer Technical Support Agreement (TSA)

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer of wireless and Ethernet connected system with a minimum of ten years record of satisfactory manufacturing and support of systems comparable to basis of specified system design.

1.9 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.

1.10 PROJECT SITE CONDITIONS

A. System design is integrated with Owner's existing network, including 802.11 wireless, wired Ethernet, or PoE network; limited to devices equipped with wireless or Ethernet (PoE) technology.

B. Conductors and Cables: Comply with requirements of Division 27 Sections "Common Work Results for Communications" and "Communications Horizontal Cabling.

C. Signal and Control Circuits: Manufacturer recommended stranded, single conductors, or twisted-pair cables.

D. Data Circuits: Category 5 minimum, twisted-pair cable.

1.11 WARRANTY

A. Manufacturer shall provide a two-year limited warranty for Education Series Analog Clocks equipped with Bluetooth® low energy wireless technology.

B. Manufacturer shall provide a two-year limited warranty for Non-Education Series Clocks equipped with Bluetooth® low energy wireless technology.

C. Manufacturer shall provide a two-year limited warranty for Bridge devices equipped with Bluetooth® low energy wireless technology.

D. Manufacturer shall provide a two-year limited warranty for Clock devices equipped with Power over Ethernet (PoE) technology.

E. Manufacturer shall offer an extended warranty on system devices.

1.12 SOFTWARE MAINTENANCE

A. Manufacturer shall offer an annual Technical Support Agreement (TSA); agreement shall be inclusive to system software access, phone/email technical support, software maintenance and revisions, and firmware revisions.

B. All system updates, enhancements and maintenance are performed per agreed upon TSA.

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. The specifying authority must approve an alternate system.

2.2 MANUFACTURER

A. System shall be manufactured by:

US: Primex, 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 SOFTWARE

A. Basis of Design Software Product: Primex OneVue™ Wireless Clock System.

B. System Software Platform: Cloud-based software platform that resides on Amazon Web Services (AWS) and is accessed via the internet.

C. System stores and monitors system devices operating conditions.

D. All system device and system settings are managed within the system software.

2.4 SYSTEM DEVICES & ACCESSORIES

A. Analog Clocks

1. Clocks shall meet the following specifications:

a. Clocks (single sided) shall be wall mounted.

b. Additional colors, finishes, and dial faces are available from Manufacturer.

c. Clock faces can be customized by Manufacturer to display organization name or logo as specified.

d. Clock frames and lenses are of durable thermoplastic.

e. Clocks shall have a tamper proof/theft resistant clock-lock mounting slots.

f. A dual-mount kit is available from the Manufacturer that combines two single clocks to create a dual-sided clock.

g. Clocks shall be capable of automatically adjusting for Daylight Saving Time.

h. Battery-operated analog clocks shall have a 5-year nominal battery life.

i. Installer will furnish clock batteries in accordance with Manufacturer instructions.

j. SUPPLY MODELS - Analog Clocks

(1) Education Series

Technology: Bluetooth® low energy wireless technology

Size: [12.5"] [16"]

Color: Black

Power: Battery

B. Bridge

1. Bridge shall meet the following specifications.

a. Enclosure: ABS plastic | Dimension: 4.7" H x 3.7" W x 1.3" D (11.93cm x 9.39cm x 3.30cm) | Weight: 0.3 lb (136 gram) with 2 AA batteries

b. Display: Liquid crystal display (LCD), dimension: 0.75 in. H x 1.38 in. W (1.90 cm x 3.50 cm) | LED Status Indicator: green, yellow, red

c. Mounting: Keyhole slot with lock down screw holes in back panel for wall mount; or surface mount with supplied dual-lock adhesive mounting strips.

d. Configuration: configured from system software or locally at device with supplied device configuration software

e. Backup Battery-power: 3.0v Primex Lithium/Iron Disulfide Battery Pack or two stand-alone 1.5v Lithium AA batteries. Use of alkaline batteries is not recommended.

f. Local memory storage capacity: configuration data for up to 1400 Bluetooth clocks.

g. Environment: Operating Temperature: 32 °F to 122 °F (0 °C to 50 °C), indoor use only|Storage Temperature: -4 °F to 140 °F (-20 °C to 60 °C)

h. Certifications: FCC, CE, and IC compliant

i. SUPPLY MODELS - Bridge

(1) Technology: [802.11 Wireless] [Ethernet (PoE) Technology]

(2) Power: Power over Ethernet (PoE)

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.

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. Comply with requirements of Division 26 Sections "Common Work Results for Communications" and "Communications Horizontal Cabling."

E. Cables: Install cables in raceways and cable trays except within consoles, cabinets, and desks [and except in accessible ceiling spaces and framed partitions where exposed wiring is allowed by Owner]. Install plenum cable where required. Conceal cable installation where possible.

F. Provide and install 12.5” in all rooms, except Cafeteria and Gymnasium.

G. Provide and install 16” clocks in Cafeteria, Gymnasium, and Auditorium. Provide wire guards as indicated.

H. Bridges shall be installed in all IDF/MFS or as required by Simplex Grinnell for a complete and operationally stable system.

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.

3.4 SERVICES

A. Manufacturer system software user guides and system device installation guides shall be provided electronically.

B. Commissioning General: Provide system commissioning in accordance with Manufacturer written recommendations. Perform operational testing to verify compliance with requirements. Adjust as required.

C. Services shall include specified level of commissioning services.

1. On-site commissioning service: system deployment training, including system set up, validation of device preconfiguration, system functionality, verification of device network connections, and device installation training.

3.5 CLEANING

A. Prior to final acceptance, clean exposed surfaces of devices, using cleaning methods recommended by Manufacturer.

3.6 DEMONSTRATION

A. Initial Demonstration and Training: provide demonstration and training for Owner facility staff that is responsible to perform system software administration.

B. Demonstrate maintenance procedures for system devices.

C. Demonstrate the system software components and features, including monitoring and management of system devices.

3.7 PROTECTION

A. Protect finished installation until final acceptance of the project.

3.8 TESTING

A. All system devices must be tested at their operational installation location under normal operational conditions.

3.9 SPARE EQUIPMENT

A. The Electrical Contractor shall furnish and install 10% of clocks with batteries, as directed by Owner. If this equipment is not installed, turn over to Owner as attic stock.

END OF SECTION 26 0731

SECTION 26 0740
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, Center for Educational Technology (DCET).

B. The following names shall be the only hardware and cable manufacturers considered for this project at this time:

1. Hardware
   a. Ortronics, Inc.
   b. Hubbell Premise Wiring Channel Solutions
   c. Systimax Solutions
   d. Siemon
   e. Leviton NextLAN
   f. Panduit
2. Wire and Cable

Indoor	Outdoor
a. Berk-Tek	a. Superior Essex
b. Mohawk/CDT	

C. In general, the network sub-contractor will furnish, install and test all cabling and terminations herein specified for distribution of the station/field wiring.

D. It shall be the responsibility of this Contractor to obtain the current State Standards and Specifications. This document shall be a guideline for installation and basis for estimating.

E. 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

The MDF shall be connected to each IDF via a single, twelve- strand, composite, 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.

C. The hardware shall include equipment racks, patch panels, station outlets, Cat 6 data cables, optical fiber cables, all required terminations and labeling to provide for a complete data distribution system.

D. 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 voice, data, and video 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/Volp 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.

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 DATA OUTLETS

A. The jacks used for the data outlets shall be of the modular snap-in type.. A modular 110 PCB RJ-45 telephone jack (45* angle) will be used for all CAT 6 data/volp grade cable terminations. All modular jacks will be mounted in a single or double gang faceplate based on the number of services required at that station. All RJ-45 jacks shall have dust covers installed.

The jack color code and lettering scheme is as follows:

1. Data/Voice Jack Cat 6 data grade cable blue tab – Data

2.2 MDF and IDF EQUIPMENT RACKS

A. The MDF and each IDF shall contain a minimum of one (1) 23.75” wide x 7’-0” high equipment rack to mount the data electronics and patch panels onto. The equipment racks shall have 77.75” of rack mounting space on 19” wide rails.

B. The free-standing equipment racks shall be steel, grounded and bolted to each other and to the slab. All racks shall include rack top cable tray, cable management equipment and a 120 volt power strip.

C. Provide one (1) server rack in MDF Room. Rack to be 4 post frame with steel rails, 44 rack units, 6” to 32” adjustable mounting rails. Black in color. Unit to be similar to Ortronics Mighty Mo 4-Mation Model No. OR-60400224 or approved equal.

2.3 HORIZONTAL DISTRIBUTION SYSTEM

A. Horizontal Cable Specifications:

Indoor:

1. Plenum, 4 pair, 24 awg, Category 6 data/voice cable (blue jacket).
2. Plenum, 12 strand, tight buffer, OS2 Single Mode fiber optic cable.
3. RG-6U, solid 18 awg copper, dual shielding aluminum foil and aluminum.
4. Plenum, 25 pair, 24 AWG, category 5E voice trunk lines.

Outdoor

1. Four (4) pair, 23 AWG, Category 6 Data Cable (black jacket) shielded, weatherproof, Superior Essex #BBDG6.
2. Twelve (12) strand, OS2 single mode, tight buffer fiber optic cable, weatherproof, plenum Superior Essex.
3. Fifty (50) pair, 22 AWG, twisted pair, copper, dual shielded weatherproof, Superior Essex PE-39.

B. Cable Support Systems:

1. Cable support system shall be of type LeGrand Cablofil wire mesg tray model CF 105/500 or equal.
2. J-Hooks shall be used in all rooms to the common path or cable support system.

2.4 CABLE TERMINATIONS

A. All classroom data outlet jacks shall be wired with Cat 6 data cable using the TIA/EIA-568-B standards. In the IDF and MDF rooms the data contractor shall furnish and install rack mounted patch panels, the number of patch panels and number of required ports shall be based on the number of classroom data outlets being terminated. On the rear of these patch panels the data contractor shall terminate each Cat 6 cable from the each classroom data outlet. Each port shall be labeled as to room and data outlet served.

B. All office, work and conference room data jacks shall be wired with Cat 6 data cable using the TIA/EIA-568-B standards. In the MDF/IDF room the data contractor shall furnish and install rack mounted patch panels, the number of patch panels and number of required ports shall be based on the number of data outlets being terminated. On the rear of these patch panels the data contractor shall terminate each Cat 6 data cable from the administration area. Each port shall be labeled as to room and data outlet served.

C. In the MDF/IDF room the data contractor shall furnish and install one (1) rack mount interconnect center, with required adapter plates on the MDF rack. The data contractor shall

terminate each twelve (12) strand fiber optic cable from each classroom IDF rack and using duplex SC adapters.

D. In the MDF/IDF Rooms the data contractor shall furnish and install on the plywood backboards, the required number of 110 termination punch down blocks with block covers and wire manager to terminate all voice cable required. Each four (4) pair termination block shall be labeled as to room served.

E. In the MDF/IDF Rooms, the data contractor shall furnish and install on the plywood backboards, the required number of 110 termination punch down blocks with block covers and wire manager to terminate required 25 pair CAT 5E trunk cables required for each area voice lines.

PART 3 – EXECUTION

3.1 INSTALLATION PRACTICES

A. Installation shall include delivery, unloading, setting in place, fastening to walls, floors, ceilings, or other structures where required, interconnecting wiring of system components, equipment alignment and adjustment, and all other related work whether or not expressly defined herein. Installation shall be performed in accordance with applicable standards, codes, requirements and recommendations of National, State, and Local authorities having jurisdiction, and the N.E.C. (National Electrical Code).

B. All boxes, equipment, etc., shall be installed plumb and square, and firmly secured in place.

C. Conduit sleeves shall be installed from the station outlet to within 12” of the cable support system. These sleeves shall be the responsibility of the data contractor and are required to accommodate both the data and communication wiring. After completion of the data and communication wiring the data contractor shall fire seal all sleeves with a UL approved fire stop in accordance with the NFPA (National Fire Protection Agency).

D. All sleeves shall be EMT conduit installed with plastic conduit bushings to protect data and communication wiring from damage.

E. In all cases, the Fiber Optic, Cat 6 data, and all communication cables shall be installed above the ceiling structure in the cable support system. No cable shall be exposed on any ceiling or wall, nor shall any cable lay-on or be in contact with the ceiling structure or it’s support system. The data contractor shall furnish and install large conduit sleeves above non-accessible ceilings where the cable support system must pass through, these sleeves shall be sized to handle both data and communication cabling.

3.2 CABLE INSTALLATION

A. All data cables shall be installed in accordance with manufacturer’s recommended tension and bending specifications. Any lubricants used must be manufacturer guaranteed to be non-destructive to cable sheaths.

B. All data cables shall be permanently marked with a wrap-around vinyl self-laminating printable marker label (Thomas & Betts E-Z-CODE WSL or approved equivalent) at both ends. There shall be no unmarked cables within the system at any location. Labels shall contain the room number, and the location and drop number within the room. All labeling shall be typed onto the label, not handwritten. Label all cable ends and individual jacks. All jacks shall be labeled to provide visibility when viewed behind cabinets and desks. All cables shall be labeled with jack numbers to permit identification in the event of damage to jacks.

C. All data and communication cables shall not be run in close proximity to, in the same bundle, or parallel with power cables, in order to reduce signal contamination.

D. No cable shall be installed with a bend radius less than that recommended by the cable manufacturer.

3.3 FIBER OPTIC CABLE INSTALLATION

A. The fiber optic cable shall be installed in the cable support system and conduit sleeves from MDF to IDF and from IDF to classroom outlets in accordance with cable manufacturer's recommended tension and bending specifications. It will be the responsibility of the data contractor to ensure the quality of the fiber optic cable when received and prior to installation.

B. All fiber optic cable terminations shall be furnished and installed in accordance with termination equipment manufacturer's recommended and required specifications. It will be the responsibility of the data contractor to ensure the quality of the terminations when installation is complete.

3.4 TESTING

A. General Test Procedures: Before an application for final acceptance of the work will be considered, all tests stated within this section shall be satisfactorily completed. The data work shall include miscellaneous tasks, (i.e.. removal of station faceplates) deemed necessary to demonstrate compliance with the requirements of the data specifications, and cable and equipment manufacturer's 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 manufacturer's specifications and recommendations as published in their latest manufacturing manuals for proper installation and testing. In addition, the item must conform with all other related industrial practices and standards, Building Trades, and Electrical and Telecommunications Industry Standards and Practices.

C. Copper Cable Test Procedures: Contractor must complete cable system performance verifications on all copper and fiber cable as specified below and provide the test results. Category 6 and fiber optic cables must meet or exceed all manufacturer's and EIA/TIA standards for performance and installation.

1. All copper and fiber optic testing documentation is to be submitted.
2. After the installation is complete, in addition to any other required testing, the data contractor shall at a minimum, conduct and report on the following tests of copper cabling:
   a. MDF-to-IDF tests of all new pairs installed under this contract to determine continuity, shorts, crossed pairs, correct pinning and grounds.
   b. IDF to information outlet tests of all cable pairs installed under this contract to determine continuity, shorts, crossed pairs, correct pinning and grounds.
   c. The Category 6 cabling, serving jacks installed from the IDF closet to the data outlets at the workstations is to be manufacturer verified and warranted for Category 6 compliance. All manufacturer's performance certificates and extended warranties are to be provided upon completion of the testing and manufacturer certification.
   d. All Category 6 cabling is to be tested end to end and documented for Category 6 compliance at all frequencies up to and including 100 MHz. Such testing is to comply with procedures and standards outlined by the cable manufacturer and EIA/TIA TSB-67 concerning testing of Category 5e cable plant. A Microtest Pentascanner Level 11 tester with 2 Way Injector is the instrument 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 Engineer within 2 days after testing or 5 days prior to the Owner connecting electronic equipment onto the cable network, whichever is sooner. The data contractor must also provide testing summary reports of all Category 5e cables including run numbers, and pass/fail results with respect to length, impedance, DC resistance, mutual capacitance, attenuation, NEXT loss and active ACR. The data contractor must also provide spread

sheet analysis of the linearly dependent parameters of length DC resistance, mutual capacitance and attenuation the field measured values shall be compared to the specifications values on one spread sheet.

e. In the event that a Category 6 cable fails to perform to the manufacturer's specifications, the data contractor will remove the cable and replace it with a new cable. Replacing the defective cable at no additional expense to the contract.

f. End-to-end testing is required for every RJ-45 connection. "End-to-End" testing is defined here as testing all cable links to the very last termination point.

g. The data contractor shall provide copies of all copper cable test results.

D. Fiber Optic Cable Test Procedures: All fiber optic cables and associated equipment, must be thoroughly tested. The fiber optic 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.

1. The data contractor shall test all cables, connectors, associated equipment and hardware furnished and installed by the data contractor upon receipt of same as defined herein.

2. The following must be met for the testing of the fiber optic cable: As a minimum the data contractor shall test, as described below, all optical fiber cable strands installed within the scope of this project:

a. Fully test complete links only. Piecemeal testing is not acceptable.

b. Perform end-to-end, bi-directional attenuation (loss) test for each fiber strand at 850nm and 1300nm wavelengths. Conduct tests in accordance with E-526-14, method B and with test instrument manufacturer's published instructions.

1) Demonstrate that measured link loss does not exceed the value based on the number of noted connector pairs, the connector's published loss per mated pair and the cable's published loss based on distance.

2) Strands whose measured attenuation falls outside the acceptable range shall be subject to further inspection and testing to determine the nature of the fault.

3) Horizontal End-to-End testing of individual optical fibers is considered to be from each IDF closet to the data workstation outlet.

c. Faults related to connectorizations shall be corrected and the fiber re-tested as stated above until acceptable attenuation measurements are received.

d. Where defects are to be inherent in the fiber itself, notify the Engineer in writing. Upon obtaining approval by the Engineer, replace any cable having fewer than the manufacturer's guaranteed number of serviceable fibers.

e. Remove all newly installed defective cables from cable support system. Do not abandon cables in place.

f. All test results and corrective procedures are to be documented and submitted to the Engineer.

g. Recommended test equipment:

1) Optical fiber power meter and Light Source: Siecor CPM-950/1300 meter and OS-100D Light Source, or equivalent.

2) TDR-Tektrom TFP2 FiberMaster, Laser Precision TD-2000 or equivalent with 850nm and 1300nm emitter modules and bud copy printout, or equal.

3) Optical fiber inspection scope: Cambridge Instruments 10x fiber scope or equivalent.

h. All fiber optic cabling is to be installed in a manner to comply with and allows DCET to receive the manufacturer's extended warranty. The data contractor is to be certified and authorized to provide the extended warranty.

E. Replacement: Any fiber strand, connector, or module installed by the data contractor which fails to meet the loss budget or tests below the manufacturer's standards, shall be replaced at no additional cost to the project. 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 be accepted.

F. Documentation:

1. Proper labeling and documentation will allow a technician to quickly trace a particular cable link and will significantly reduce the time and cost of moves, adds, changes and troubleshooting. Both labeling and documentation depend on the use of a system-wide coding scheme that will identify and locate each component of the data system and allow all components to be linked in a logical fashion.
2. There are three components of wiring system documentation:
   a. Labeling data closet termination areas aids in identifying the source and function of a circuit.
   b. A labeling scheme simplifies the documentation process.
   c. "As-built" documents provide a permanent record of data infrastructure. These documents are a critical management resource. As a result, it is imperative that "as built" documentation be prepared as part of the data infrastructure project. In addition, these documents must be kept current throughout the system's life cycle.

G. Cable and Data Outlet Identification:

1. The data contractor shall furnish and install cable tags labeled with identifying cable numbers.
2. The data contractor shall clearly and consistently mark the appropriate designation strip labels on all hardware. Data contractor shall submit for approval a sample of all designation labels.
3. The data contractor shall affix outlet identification labels, machine printed or typed, with identifying cable numbers.
4. Subsequent to pulling and terminating cables, the data contractor shall place the appropriate cable tags within six (6) inches of each Category 5e cable and eighteen (18) inches of each optical fiber cable end.
5. If at any time during the project, the cable tape becomes illegible or removed, the data contractor shall immediately replace it with a duplicate preprinted cable tag.
6. The data contractor shall provide a listing keyed to cable types of all cable identification numbers.
7. Data contractor shall label each data outlet with the following label scheme:

   If the IDF closet "A" is the origination point of the cable feeding the data outlet "007"in classroom 129, the following is the configuration of the label to be installed;

   IDF Closet – Classroom-data outlet

   Example: A-129-007

   Data contractor will submit for approval sample of all data outlet designation labels.

H. As-Built Documentation:

1. Maintaining records and documents is the most important portion of the administration of a data infrastructure. Maintenance and moves, adds and changes can become very tedious if a current set of records and documents are not maintained. In fact, isolation and resolution of problems are often delayed because configuration information is either unavailable or outdated.
2. Subsequent to the installation and prior to acceptance, the data contractor shall prepare and issue As-Built drawings, in an AutoCAD format latest version, that shall reflect the lengths of cables installed, the actual manner and conditions of installation, including all deletions from additions to or departures from the contract documents. The documents are to include the data outlet station numbers and cable routing where it varies from the original plan. A copy of these documents will be stored in the MDF, with a master copy located at the School District's office.

END OF SECTION 26 0740

SECTION 26 0771
INTERCOM/TELECOMMUNICATION SYSTEM

PART 1 – GENERAL

1.1 General

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division l 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.

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 volp 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 a 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.

1.6 Warranty and Maintenance

A. Provide a two (2) 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

<u>Alcatel Lucent Volp System</u>

A. The contractor shall provide a complete and satisfactory telephone system. All equipment and installation material requirements shall be furnished and installed including the interfaces to intercom and voice mail systems.

l. 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 02LS2: 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 mutli-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 part 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)

l. 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 (l) 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 (l) 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 (l) 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 (l) 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.

l. 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 detective.

D. UL Listing: The system shall be UL8l3 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.

l. 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 #l: 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 16l0Hz. 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 + ldB. Dynamic range shall be 92dB with a total harmonic distortion of 0.007% at lkHz. 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:

l. Simplex Building Systems

2.2 EQUIPMENT

A. Alcatel Lucent Omni PCX Enterprise Communications System

B. Intercom/Public Address System

1. Simplex 5120 Integrated Communication System

2.3 PBX TELEPHONE SYSTEM

A. Office Phones #8038

Classroom Phones #8018

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. Volp 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.

<u>MAIN DISTRIBUTION FRAME (MDF)</u>

A. Volp system server to be mounted in server rack.

<u>WALL PLATES AND JACKS</u>

A. See Specification Section 260741.

<u>POWER SUPPLY AND TRANSIENT/SURGE PROTECTION</u>

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.

E. Middle School/High School shall be a combined system with the main headend equipment located in High School MDF and remote panel located in the Middle School IDF.

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.
2. Commons area speakers: 2 conductor, 18 AWG, stranded, plenum.

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.

Qty	Description
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 0851
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, a = .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:

<u>Temperature:</u>

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

<u>Ground Fault:</u>

Alarm Range:	20 to 100 mA
Trip Range:	20 to 100 mA or OFF

<u>Current:</u>

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. <u>Alarm Conditions</u>

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 26 0851

SECTION 26 0961
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 work in the following spaces:
   1. Auditorium
   2. Black Box

B. This section includes furnishing the following equipment for installation as described under Section 260963:
   1. Dimmer Racks
   2. Dimmer Modules
   3. Relay Panels
   4. Panic Control System
   5. Emergency Lighting Transfer System
   6. Equipment Racks
   7. House & Work Lighting Controls
   8. Lighting Control Console & Accessories
   9. Ethernet Network System
   10. Control Device Faceplates
   11. Performance Lighting Device Faceplates
   12. Cable Assemblies
   13. Spare Parts

C. Alternate 30 includes all labor, materials, equipment, and services necessary to complete the following:
   1. Black Box Lighting Control Console & Accessories

D. 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. Acoustical Shells
   6. Rigging Systems and Controls
   7. Catwalks & Wire Rope Assemblies
   8. Commissioning of Electrical Systems

E. 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. Acoustical Shells
   6. Rigging Systems and Controls
   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. Dimmer Rack: Cabinet accommodating dimmer modules, load and line connections, and circuit protection.

B. Plug-In Module: Modular unit that installs in standardized mounting location within dimmer rack.

C. Dimmer Module: Plug-in module containing one or more dimmers.

D. Control Module: Plug-in module containing centralized control electronics for dimmer modules.

E. Data Communication Protocol: Signal that provides control and feedback communications between devices in control system.

F. DMX 512: Data communications protocol compliant to USITT DMX-512/1990 specification (ANSI E1.11-2004).

G. RDM: Data communications protocol compliant to ANSI/PLASA Remote Device Management specification (ANSI/PLASA E1.20 RDM).

H. ACN: Data communications protocol compliant to ANSI/PLASA Architecture for Control Networks specification (ANSI E1.17-2006 ACN & E1.31 Streaming ACN).

I. POE / Power Over Ethernet: 802.3AF 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. Post-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: Uniform sheet size.
   2. Binding: Bind shop drawings of more than five drawings.
   3. 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.
   4. Review: Fabrication shall not commence until Theatre Consultant and Architect determine that the shop drawings are in compliance with design intent of Contract Documents.
   5. Revisions: Resubmit as required.

C. Manuals
   1. Format: Letter and/or tabloid size paper.
   2. Binding: Standard 3-ring binder.
   3. Electronic Format: PDF files on USB flash drive.
   4. 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: Letter and/or tabloid size paper.
   2. Binding: Standard 3-ring binder.
   3. Electronic Format: PDF files on USB flash drive.
   4. Delivery: Within one month of system acceptance.
   5. 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 MANUFACTURER

A. The equipment shall be manufactured by the following:
   1. Electronic Theatre Controls
      3031 Pleasant View Road
      Middleton, WI 53562
      608.831.4116
   2. Substitutions: See Section 016000.

B. The equipment may be supplied by one of the following:
   1. 4Wall
      35 State Street
      Moonachie, NJ 07074
      201.329.9878
   2. Barbizon
      456 W 55th Street
      New York, NY 10019
      212.586.1620
   3. Candela Controls
      15 Oweno Place
      Mahwah, NJ 07430
      201.529.2423
   4. Starlite Productions
      9 Whittendale Drive
      Moorestown, NJ 08057
      856.780.8000

C. Furnishing: Equipment and services shall be provided by one manufacturer.

D. Experience: Manufacturer shall have been continuously engaged in production of performance lighting and control equipment for at least 20 years.

E. Emergency Support: Manufacturer 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. Manufacturer 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 DIMMER RACKS

A. Basis of Design: Sensor3 power control system

B. General
   1. Dimmer racks shall be dead front switch boards complete with all dimmers, control electronics, timers, circuit breakers, and wiring terminations. No external components shall be required.
   2. Auxiliary racks shall be available to provide mounting of subcomponents including main circuit breakers, branch circuit breakers and control components.
   3. Mounting: Floor mount, front access to allow back-to-back or side-by-side installation.
   4. Maximum Dimensions: 84” high x 15” wide x 23” deep.
   5. Electrical operation: 90 to 264 VAC 3 phase, 4 wire + ground, 47 to 63 Hz service.
   6. Feed Size: Accept up to 800A per phase.
   7. Power distribution: Copper buss bars. Aluminum buss bars are not acceptable.
   8. Multiple rack bussing: As required, with optional equipment kit.
   9. Listing and label: UL/cUL
   10. Ventilation: forced filtered air using multiple low-noise fans providing redundancy in case of fan failure.
      a. Configure fans to turn on when control is energized.
      b. Maintain operating temperature of all components under full load when ambient temperature of dimmer room does not exceed 40°C/104°F.
      c. Fans shall remain on during thermal shutdown.
   11. Provide racks configured to receive electrical services shown on electrical Drawings. Provide internal inter-rack bussing as required.
   12. Provide terminals to accept feed and branch wire sizes shown on Drawings.
   13. Fault current protection rating: 100,000 SCCR.
   14. Key module spaces to accept only module amperage specified.
   15. Module space circuit identification height: 1/4". Verify to match as-built conditions.

16. Dimmer 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
17. Dimmer rack 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 dimmer numbers listing use, circuit identification, dimmer type, and load; load information verified to match final as-built conditions
18. Mason Industries ND double deflection neoprene-in-shear type vibration isolation pads shall be provided for each dimmer rack. Neoprene shall be no harder than 50 durometer.

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. Rack setup
    b. Rack status
    c. Dimmer load
    d. Temperature monitoring
    e. Output voltage adjustment per dimmer module
    f. System configuration
    g. Operating parameters, presets, levels, fade times
3. Rack shall accept two DMX-512/1990 control signal inputs 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) and ANSI E1.17 (ACN) network protocols. 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 DIMMER MODULES

A. SCR Dimmer Modules
1. Each module shall contain:
    a. Circuit breakers
        1) Fully magnetic
        2) Trip current shall not be affected by ambient temperature
        3) Rated for tungsten loads having an inrush of no less than 20 times normal current.
        4) Switching duty application rating: 100%
        5) Load rating: continuous operation at 100% load
    b. Solid-state switching module
        1) Encapsulated in high impact plastic cases
        2) Isolation: 2,500 volts RMS between AC line and control lines
    c. Toroidal filters
        1) Reduce rate of current rise time.

2) Limit objectionable harmonics
3) Reduce lamp filament "sing"
4) Limit radio frequency interference on line and load conductors.

d. Power and control connectors

2. Key modules to prevent interchangeability of modules of differing capacity.
3. Module shall be capable of "hot patching" cold incandescent loads up to full rated capacity without malfunction with control signal at full.
4. Standard Rise Time Dimmers
   a. Dimmer shall have a rise time of not less than 500µs measured at 90 degrees conduction angle from 10% to 90% of output wave form with dimmer operating at maximum load. Voltage rate of rise (slew rate) must not exceed 300 mill volts per microsecond in any point of the wave under full load conditions.

B. Bypass Dimmer Modules
1. Dimmer with bypass modules shall be designed for dimmed, non-dim, or hot power on each 20A branch circuit. Module configurations shall be:
   a. Two dimmed outputs with 500µs rise times.
   b. Two air gap relay switched outputs.
   c. Two manual bypass constant power circuits.
2. Module may be configured to operate as two dimmers, two relays, or any combination of relay and dimmer from the dimmer rack control module or from manufacturer's control console connected to a network-based system. Any single circuit may be set to bypass dimmer using switch on front of module.
3. Module construction shall be similar in all respects to standard SCR dimmer modules above and shall be interchangeable with modules of the same rating.
4. Listing and label: UL/cUL

C. Non-Dim & Constant Modules
1. Non-dim modules shall utilize a latching type relay and have a full magnetic primary circuit breaker. Modules employing solid state relays shall not be acceptable.
2. Constant circuit modules shall distribute overcurrent protected power from the dimmer rack to non-dimmed loads. There shall be no moving parts other than the circuit breakers.
3. Module construction shall be similar in all respects to standard SCR dimmer modules above and shall be interchangeable with modules of the same rating.
4. Listing and label: UL/cUL

2.08 RELAY PANELS

A. Basis of Design: Sensor IQ relay panel

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. Maximum Dimensions: 64" high x 20" wide x 5.25" deep.
4. Electrical operation: 120/208V 3 phase, 4 wire + ground.
5. Feed Size: Accept up to 400A per phase.
6. Listing and label: UL/cUL; UL508, UL67, UL924
7. Provide terminals to accept feed and branch wire sizes shown on Drawings.
8. Fault current protection rating: 65,000 SCCR.
9. Voltage Separation: Provide between high voltage and low voltage compartments.
10. 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.

11. Branch circuit capacity: 48 poles, 15A to 30A one, two, and three-pole circuits as required.
12. 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
13. 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.

2.09 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.

2.10 EMERGENCY LIGHTING TRANSFER SYSTEM

A. Basis of Design: ELTS2

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

2.11 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

2.12 HOUSE & WORK LIGHTING CONTROLS

A. Basis of Design: Unison Paradigm

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. Preset Stations

1. Preset stations shall consist of programmable momentary pushbutton switches.
   a. Finish: Shown on drawings
   b. Provide flush or surface backbox
2. Pushbuttons shall provide control of a single channel, lighting processor preset, sequence, fade time, macro, timeclock event, and/or interfaced external system as required.
3. Preset Stations shall connect to control system using Manufacturer’s recommended wire type, network topology, and communication protocols.

E. 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.

F. 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.

2.13 LIGHTING CONTROL CONSOLE (AUDITORIUM)

A. Basis of Design: Ion Xe 20

B. General
1. Lighting control console shall be a microprocessor-based system specifically designed to provide complete control of performance lighting systems.
2. Minimum Capacities:
a. Control outputs: 12,288
b. Programmable faders: 20
c. Master playback faders: 2
d. Rotary encoders: 4
e. External multi-touch screen capability
f. Remote video support
g. 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
3. User interface shall be fully graphical with command line. Control commands shall be accepted as either command line or direct entry.
4. The main control shall consist of numeric keypad, dedicated control keys, context sensitive soft keys, level control wheel, and pointing device.
5. A blind display mode shall allow viewing and modification of all recordable attributes without affecting live stage levels.
6. A patch display mode shall be used to display and modify system control channels with their associated data.
7. 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.

8. 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.
9. Simultaneous playback of recorded cue lists shall be possible on up to 200 faders.
10. The console shall be capable of being placed in Tracking or Cue Only record mode by the user.
11. Integrated, integral virtual media server shall allow mappable images and animations to rig array. System shall be capable of 40 maps, 12 layers each.
12. 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.
13. A freely available offline editing application shall be provided for creation and modification of show data on a personal computer.
14. 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.
15. The system shall allow remote control from a wireless handheld remote.
16. 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 with the console (2) external 22” multi-touch monitors, keyboard, mouse, and task lights.

D. Provide Wireless Hand-Held Remote capable of setting individual channels and groups of channels to levels, raising and lowering the levels, stepping automatically to the next or last cue or channel, going to and playing back individual cues.

E. All peripheral accessories such as remote monitors and hand-held remote units shall interconnect as a network. The facility shall be wired by the Electrical Contractor for this function with an Ethernet cabling system as specified herein.

F. Furnish the following console accessories:
1. Vinyl dust covers for the consoles and monitors. Dust covers shall cover top, sides, front and rear surfaces of equipment.
2. Cables for control console and remote video interface
   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. 4 GB capacity USB storage keys: 2

2.14 LIGHTING CONTROL CONSOLE (BLACK BOX) – ALTERNATE 30

A. Basis of Design: Ion Xe 20

B. General
1. Lighting control console shall be a microprocessor-based system specifically designed to provide complete control of performance lighting systems.
2. Minimum Capacities:
   a. Control outputs: 12,288
   b. Programmable faders: 20
   c. Master playback faders: 2
   d. Rotary encoders: 4

e. External multi-touch screen capability
f. Remote video support
g. 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

3. User interface shall be fully graphical with command line. Control commands shall be accepted as either command line or direct entry.
4. The main control shall consist of numeric keypad, dedicated control keys, context sensitive soft keys, level control wheel, and pointing device.
5. A blind display mode shall allow viewing and modification of all recordable attributes without affecting live stage levels.
6. A patch display mode shall be used to display and modify system control channels with their associated data.
7. 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.
8. 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.
9. Simultaneous playback of recorded cue lists shall be possible on up to 200 faders.
10. The console shall be capable of being placed in Tracking or Cue Only record mode by the user.
11. Integrated, integral virtual media server shall allow mappable images and animations to rig array. System shall be capable of 40 maps, 12 layers each.
12. 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.
13. A freely available offline editing application shall be provided for creation and modification of show data on a personal computer.
14. 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.
15. The system shall allow remote control from a wireless handheld remote.
16. 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 with the console (2) external 22” multi-touch monitors, keyboard, mouse, and task lights.

D. Provide Wireless Hand-Held Remote capable of setting individual channels and groups of channels to levels, raising and lowering the levels, stepping automatically to the next or last cue or channel, going to and playing back individual cues.

E. All peripheral accessories such as remote monitors and hand-held remote units shall interconnect as a network. The facility shall be wired by the Electrical Contractor for this function with an Ethernet cabling system as specified herein.

F. Furnish the following console accessories:
    1. Vinyl dust covers for the consoles and monitors. Dust covers shall cover top, sides, front and rear surfaces of equipment.

2. Cables for control console and remote video interface
   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. 4 GB capacity USB storage keys: 2

2.15 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 802.3af 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 802.3af products.
      e. Provide 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 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 lighting system Configuration Computer(s) as shown on Drawings.
      a. Computer shall be an industrial PC
         1) Intel-based multi-core processor with clock frequency higher than 2.0 GHz
         2) 8 GB RAM
         3) 128GB SSD hard drive
         4) Video resolution output of 1920x1080
      b. Provide most current Windows based operating system compatible with the proprietary application software and system configuration.
      c. Provide network configuration software as required to allow online and offline configuration and operation of all system parameters, dimmer rack configuration settings, and system monitoring.
      d. Provide house and work lighting controls configuration software.
      e. Provide console client software and any associated hardware dongles to remotely view and interact with the lighting control console.
      f. Software shall be preinstalled on configuration computer(s) and furnished complete with installation discs and manuals.
   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.
f. Portable nodes shall be supplied with 100'-0" ProPlex Category 6a ethernet cable extension with black Neutrik etherCON CAT6a connectors for each node.

2.16 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.
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.

2.17 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. 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
   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.

G. Terminals: Provide numbered screw terminals on barrier terminal blocks for field connections within each device. Devices shall be internally wired by Manufacturer. Size terminals and PL boxes per wire sizes shown on E-series drawings.

H. Mounting hardware: Coordinate device mounting requirements as noted on drawings and per field conditions.

2.18 MULTICABLE ASSEMBLIES

A. Furnish cable assemblies in quantities and types as shown on the Drawings.

B. All assemblies shall be tested after fabrication to assure wire continuity and correct polarity of connections.

C. Multicable Extension assemblies shall consist of 12/14 SOOW cable terminated at each end with TMB PS19 series inline receptacles with soldered terminals, heatshrink tubing, strain relief, innermodling, and overmolding. Provide strain relief grips on each end of cable assembly. Provide additional double eye cable grip at male end of cable. Label extension cables at each end with shrink wrapped 1/2" text to identify cable length.

D. Multicable Breakout assemblies shall consist of (6) 12/3 SJOW cables terminating at one end to a single 19-pin male inline connector with soldered terminals, heatshrink tubing, strain relief, innermodling, and overmolding. Each free end of SJOW cable shall terminate in a female receptacle as shown on drawings. Engrave circuit number labels 1 through 6 on receptacles.
   1. Staggered assemblies shall have cable lengths from 18” to 9’-0” in 18” increments.
   2. Straight assemblies shall have a uniform cable length of 6’-0”.

2.19 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 control systems for at least 2 full days at a date and time convenient to the Owner.

END OF SECTION

SECTION 26 0963
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. This section includes work in the following spaces:
   1. Auditorium
   2. Black Box

B. The work of this Section includes all labor, materials, equipment and services necessary to install the electrical work associated with the Theatrical Lighting Controls, as described in Section 260961 and shown on the Drawings.

C. Related sections include the following:
   1. Performance Lighting Systems
   2. Common Work Results for Electrical
   3. Interior Lighting Fixtures
   4. Performance Lighting Fixtures
   5. Orchestra Lift and Chair Wagon System
   6. Rigging Systems and Controls
   7. Catwalks
   8. Commissioning of Electrical Systems

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. 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 dimmer room to the outlet devices or architectural fixture.

E. All dimmer rack 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 2861
COMPANY SWITCHES

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 work in the following spaces:
   1. Auditorium
   2. Studio Theatre

B. The work of this Section includes all labor, materials, equipment and services necessary to provide company switches as shown on the Drawings and/or specified herein.

C. Related sections include the following:
   1. Performance Lighting Systems
   2. Performance Lighting Systems Installation
   3. Common Work Results for Electrical
   4. Interior Lighting Fixtures
   5. Performance Lighting Fixtures
   6. Orchestra Lift
   7. Rigging Systems and Controls
   8. Catwalks
   9. Commissioning of Electrical Systems

1.03 QUALITY ASSURANCE AND STANDARDS

A. References to code, standards, specifications and recommendations of technical societies, trade organizations and governmental agencies shall refer to the latest edition of such publications adopted and published prior to submittal of the bid. All such codes and standards shall 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, 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 (1) switchboards and panelboards and (2) stage lighting and control equipment.
   4. NEMA Compliance pertaining to components of stage lighting equipment.

1.04 SUBMITTALS

A. Post-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. Statements:
      a. Manufacturer agrees to warranty provisions.
      b. Manufacturer confirms that submitted equipment's listings and labels comply with installed locations shown on drawings.
   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: Uniform sheet size.
2. Binding: Bind shop drawings of more than five drawings.
3. 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.
4. Review: Fabrication shall not commence until Theatre Consultant and Architect determine that the shop drawings are in compliance with design intent of Contract Documents.
5. Revisions: Resubmit as required.

C. Manuals
1. Format: Letter and/or tabloid size paper.
2. Binding: Standard 3-ring binder.
3. Electronic Format: PDF files on USB flash drive.
4. 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.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURER

A. The equipment shall be manufactured by the following:
1. Electronic Theatre Controls
3031 Pleasant View Road
Middleton, WI 53562
608.831.4116
2. Lex Products
401 Shippan Ave
Stamford, CT 06902
203 363 3738
3. Union Connector
8182 Baymeadows Way West
Jacksonville, FL 32256
631 753 9550

B. Substitutions: See Section 01600.

C. When a manufacturer's product has been replaced by a newer model prior to shipment, the later model shall be furnished provided the new model retains or exceeds all of the specified characteristics of the product specified herein.

D. All equipment must be tested and labeled at factory prior to shipment.

2.02 COMPANY SWITCHES

A. Company switches shall be from one of the following product lines:
   1. Electronic Theatre Controls PowerSafe Pro
   2. LEX Products PowerGATE
   3. Union Connector Company Switch w/Connection Chamber

B. General
   1. Company switches shall be a specialized power distribution panel for the connection of portable electrical equipment in theatres, auditoriums and other places of public entertainment.
   2. Enclosure dimensions shall not exceed 57” high x 28” wide x 12” deep.
   3. Enclosure shall have a NEMA 1 rating. NEMA 3 rated enclosures shall be available as an option and provided as shown on the Drawings.
   4. Company switches shall operate on 120/208 VAC, 4 wire + ground, 60 Hz service as standard. 5 Wire + ground, 200% Neutral service shall be available as an option, and provided as noted herein and shown on the Drawings.
   5. Isolated ground connections shall be provided for company switches designated for audio/video power.
   6. All connections from the main breaker to the output panel shall be by copper bus. Aluminum buss shall not be acceptable.
   7. The fault current protection rating of the main breaker shall be 65,000 SCCR minimum.
   8. Company switch shall be hipot tested at 1250VAC for no less than 10 seconds.
   9. Company switch shall have a lockable, hinged connection chamber that contains both direct wire lugs and single pole Cam-Lok series E1016 connectors.
   10. The connection chamber door shall engage the shunt-trip mechanism of the main circuit breaker whenever it is not fully closed.
   11. Neutral and Ground Cam-Lok outlets shall be female connectors.
   12. A locking mechanism shall be provided to allow a padlock or lockout tag to secure the breaker in the off position.
   13. Replaceable indicator lamps shall be provided for each supply phase, labeled with NEC specified color codes and alphabetic names of phases.
   14. Replaceable indicator lamp shall be provided for ground integrity.
   15. A warning label specifying the proper sequence for connection and removal of cable connectors shall be permanently attached to the enclosure, as mandated by the NEC.

C. Identification Label
   1. Provide signage on each company switch permanently attached to the equipment indicating the following:
      a. Panel identification name and number
      b. Feed type and size
      c. Feed source
   2. Character size shall be 1/4" high letters for equipment designations and 3/16” high letters for subsidiary information.

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.

3.02 INSTALLATION

A. Install company switches 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. Field terminations shall be through conduit to terminals on the main breaker.

C. Wire nuts and field soldered connections, except where noted, shall not be acceptable.

D. Equipment shall be grounded, as shown on drawings and in accordance with applicable codes and regulations and/or at the advice of the Manufacturer.

3.03 COMMISSIONING

A. Prior to energization of the equipment, perform the following tests and inspections. Correct deficiencies and retest deficient items.
   1. Inspect each device 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. Verify correct phase relationship and capacity.
   5. Set calibration of overcurrent protection.
   6. Measure / adjust the voltage at each phase output receptacle. Voltage requirements shall be determined by the Electrical Engineer.

3.04 DEMONSTRATION AND ACCEPTANCE

A. The Architect and/or owner's 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.

B. Subject to the on-site demonstration being satisfactory, the Architect and/or owner's representative shall accept the equipment on behalf of the Owner.

C. Should the demonstration prove unsatisfactory, the Theatre Consultant and the Architect and/or owner's representative shall 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 6010
RIGGING SYSTEMS ELECTRICAL WORK

PART 1 GENERAL

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 work in the following spaces:
   1. Auditorium

B. The base bid 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. Capstan winch
   2. Motorized fire curtain

C. The work of this Section associated with Alternate 16B 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 hoists for orchestra shell ceiling

D. The work of this Section associated with Alternate 13 includes all labor, materials, equipment and services necessary to complete the Orchestra Lift installation, as shown on the drawings and specified herein, including, but not limited to, the following:
   1. Orchestra lift

E. 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.

F. Electrical service for the above work is shown on the E-series drawings.

G. The TR-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 4117
SOUND, VIDEO & COMMUNICATION SYSTEMS

PART 1 - GENERAL

1.1 GENERAL DESCRIPTION

A. The purpose of this Section is to provide the Contract Specification for the Production Sound, Video, and Communication Systems for the Appoquinimink High School Proscenium & Black Box theaters.

1.2 RELATED DOCUMENTS

A. The Subcontractor shall read, review and understand all documents listed below prior to bidding or proceeding with work. The Subcontractor shall also refer to and understand all other related documents indicated herein.

B. This section of the Specification.

C. The Production Sound, Video, and Communication Systems drawings.

D. Related Architectural Drawings; for reference only.

E. Related Electrical Drawings; for reference only.

F. Contract
1. In addition to the conditions and work described herein, all conditions of the Contract shall apply.

G. Other drawings as appropriate; for reference only.

1.3 DEFINITIONS

A. In addition to the definitions in the General Conditions, the following also apply to this Section:
1. The term “Architect” refers to ABHA / BSA+A.
2. The term “Electrical Engineer” refers to Furlow Associates Engineering.
3. The term “Consultant” refers to Acme Professional Inc.
4. The term “Successful Bidder” as used in this specification refers to that Subcontractor whose bid proposal is accepted by the Owner, and who is officially named as the Sound, Video & Communication Subcontractor.
5. The terms “Sound, Video & Communication Subcontractor”, “this Subcontractor”, “this Contractor”, “SVCC” as used in this specification refer to that subcontractor directly responsible for supply and installation of the Sound, Video & Communication Systems.
6. The terms “engineer” and “engineering” as used in this specification refers to the interpretation, organization, and execution of the design of the Sound, Video & Communication Systems as provided in the Contract Documents.

7. The term "supply" as used in this specification indicates that the Sound, Video & Communication Subcontractor shall supply, free issue, including instruction and supervision for installation by others, such equipment, components, and material of the Sound, Video & Communication Systems so as to fulfill the intent of the Contract Documents.
8. The term "provide" as used in this specification indicates that the Sound, Video & Communication Subcontractor shall supply, fabricate, install, and make operable such equipment, components, and material of the Sound, Video & Communication Systems so as to fulfill the intent of the Contract Documents.
9. The terms "pre-approved equivalent" and "or as approved" as used in this specification indicate that acceptance shall be obtained from the Consultant. Refer to "Product Substitution" below.
10. 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.
11. The terms "OEM" or "original equipment manufacturer" or "manufacturer" as used in this specification refer to a direct supplier to the Sound, Video & Communication Subcontractor.
12. The term "by others" as used in this specification and on the contract drawings indicates work not included in this section of the contract but provided by others as part of the General Contract.
13. "UON" denotes "unless otherwise noted."
14. "AFF" denotes "above finished floor."
15. "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.

1.4 SCOPE OF WORK

A. The Sound, Video and Communication Subcontractor (SVCC) shall be responsible for all labor, equipment, material, and procedures required for the supply, fabrication, installation, commissioning, and warranty of the Production Sound, Video and Communication Systems (SV&C Systems) as specified herein and on the SV&C Systems 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. 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.
1. All labor, equipment, and material.
2. Supply nonstandard back boxes and sequential power switching system equipment for installation by Divisions 26 and 27 except where noted.
3. Termination of receptacles in Sound, Video & Communication equipment racks.
4. Provide supplemental conduit, junction/pull boxes, fittings, and electrical hardware, as required for connection of SV&C equipment to the Sound, Video & Communication empty conduit system as supplied by Division 27.
5. All wire, wire pulling, and termination.
6. All tools and measuring & testing equipment required for installation.
7. Daily and final cleanup.
8. Shop drawings, samples and mock-ups, as-built documentation, and operating manual.

9. Testing and adjustment, interim shop inspection, initial test report, final site inspection, final test report, and demonstration and instruction.
10. Guarantee and warranties, and maintenance and service contract.
11. Technical Systems: see specific information about the equipment, components, and material in "PART 2 - PRODUCTS":

C. 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):
1. A complete, pull-ready conduit system for installation of Sound, Video & Communication Systems wiring and devices—including all conduit and raceway, junction/pull boxes, standard back boxes, rack room terminal cabinets and "pull group" boxes, fittings, drag line (pull line), electrical hardware, etc. (Division 27).
2. Installation of nonstandard back boxes for Sound, Video & Communication Systems devices (to be concurrent with other electrical work) (Division 27).
3. Electrical power service—including transformers, feeder cable, distribution panels, branch circuit panel-boards, and individual wall receptacles (Division 26).
4. Sound, Video & Communication Systems "sound system" isolated ground AC power network (Division 26). Note: inter-rack AC power wiring, shall be the responsibility of the SVCC. Single-point termination to the racks shall be conducted on-site by the EC.
5. Loudspeaker array rigging (Theatrical Equipment Contractor - see Section 11 6131 and Architectural Specification).
6. Equipment rooms, rack rooms, and control rooms (including lighting, furnishings, and finishes) (various Sections).
7. Painting and finishing (except as noted below for Sound, Video & Communication System equipment).
8. House telephone, data, life safety, fire alarm, and security systems (Division 28).

1.5 BID REQUIREMENTS

A. The equipment may be furnished, installed, and provided by the following:
1. SoundCom
   227 Depot Street
   Berea, OH 44017
   513-313-4807
   Michael Cunningham – mcunningham@soundcom.net

2. Sound Associates Inc
   979 Saw Mill River Road
   Yonkers, NY 10710
   914-963-3453
   Phillip Peglow – ppeglow@soundassociates.com

3. Boulevard Pro
   1275 Valley Brook Ave.
   Lyndhurst, NJ 07071
   201-262-7740
   info@blvdpro

4. Brandywine Electronics
   611 Carson Drive
   Bear, DE 19701
   302-324-9992
   www.bel.com

5. Substitutions: See Section 016000.

B. Post-bid
1. Subcontractor Submittal
   a. Submit two (2) copies of the following lists, schedules, and bills of material, including the names of manufacturers, manufacturers' model numbers, quantities, and prices:
      1) Category pricing information, separately listing equipment, wire, and labor pricing for each of the following XX (XX) categories.
      2) A complete and accurate list of all of the equipment, components, and material specified in the Contract Documents.
      3) A schedule of wire and cable as specified in the Contract Documents.
      4) A list of requests for approval of equivalent equipment, components, material, or systems, per the requirements listed in "Product Substitution" below.
      5) A list of test equipment to be used in system testing and adjustment, per the requirements listed in "Part 3 - Execution: Testing and Adjustment."
      6) 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.
      7) 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 Sound, Video & Communication Systems equipment provided by Division 26.
      8) 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 Sound, Video & Communication Systems Contract is awarded, the Successful Bidder 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.
   b. In the event that additional conduit is required to fulfill the intent of the Sound, Video & Communication Systems, the bidder shall include any additional wire in the bid.
   c. Any financial or scheduling implications for additional work specified in other sections, as recommended by a bidder, shall be assessed prior to award of this Section.
2. Construction Manager and Consultant Review
   a. The Construction Manager and 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. Based on the Construction Manager and Consultant's review, a bid not meeting these requirements shall be rejected.
   b. These lists, schedules, and bills of material are included for the purpose of evaluation. The acceptance a bid based on these submissions shall not be

understood to relieve the Successful Bidder of the responsibility of meeting any and all requirements of the Contract Documents.

3. Product Substitution
   a. The Sound, Video & Communication Systems equipment, components, and material specified are called out in terms of products as supplied by specific original equipment manufacturers. Bids shall only be considered from those bidders who present a bid based exactly on the products specified.
   b. 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 bidder notify the Architect, within sufficient time for amendment of the Contract Documents,
   c. Bidders 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. Prior to the bid closing date, sufficient catalog data, specifications, technical information, and samples shall be submitted for a complete evaluation by the Consultant. Any proposed product substitutions must be submitted to the Construction Manager seven (7) calendar days prior to the bid closing date.
   d. While the equipment, material, arrangements, and procedures described in the Contract Documents indicate specific details for realization of the Sound, Video & Communication Systems, bidders may propose alternate products and details that shall fulfill the functional parameters of the outlined system. In such event, bidders 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 where the equipment, material, arrangements, and procedures that shall be offered differ from those specified in the original Contract Documents. Prior to the bid closing date, any changes to the original Contract Documents shall be evaluated and given written approval by the Construction Manager and Consultant. Any proposed alternate products and details must be submitted to the Construction Manager seven (7) calendar days prior to the bid closing date.

1.6 RESPONSIBILITIES

A. General
   1. Provide complete and working Sound, Video & Communication Systems 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.

B. 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 Sound, Video & Communication Systems.

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 Sound, Video & Communication Systems.
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.
4. Any errors, omissions or ambiguities in the Contract Documents are not to condition these requirements, but shall be brought to the attention of the Construction Manager and Consultant for evaluation of any possible effect on the intent of the Contract Documents. Submit all notifications in writing to the Construction Manager 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.

C. Coordination
1. The Owner wishes to delay key SV&C Systems equipment purchases until just prior to fabrication and installation in order to take full advantage of technology advancements. Coordinate equipment purchase schedule with Consultant and General Contractor.
2. Refer to Electrical & Technology Drawings to determine Sound, Video & Communication Systems device quantities and general locations. Refer also to Architectural drawings for exact device locations.
3. Be familiar with the requirements of Divisions 26 and 27 - Electrical to ensure the coordination of the work in this Section with the work of the Electrical Contractor.
4. Provide the Electrical Contractor with drawings, diagrams, and other information in order to ensure proper coordination of the AC power system and Sound, Video & Communication 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 Construction Manager.
5. 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.
6. References to the Construction Manager 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.
7. All drawings, schedules, RFIs, and other communication shall be coordinated with and submitted through the Construction Manager.

D. Means And Methods
1. The Sound, Video & Communication Contractor is solely responsible for the means and methods of all fabrication and installation techniques, sequences and procedures of construction, and shall be responsible for coordination of these items with and through the Construction Manager and the Consultant.

E. Sub-Contractors
1. Use of Sub-Contractors by the Sound, Video & Communication Subcontractor shall in no way modify its responsibility.

F. Suppliers
1. Use of a product from a particular original equipment manufacturer, whether specified in the Contract Documents or substituted by the Sound, Video & Communication

Subcontractor, shall in no way modify its responsibility. Refer also to General Conditions.

G. Site Dimensions And Conditions

1. The Sound, Video & Communication Subcontractor 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 Construction Manager. The Sound, Video & Communication Subcontractor 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 Construction Manager, 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 Control Rooms, House Mix Position, and Equipment Rack Rooms. 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, Video & Communication empty conduit system, as specified in Section 27 - 0527 and 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 Construction Manager and Consultant prior to shop fabrication or field installation.

H. 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 Sound, Video & Communication Subcontractor's design responsibilities shall include:
   a. Interpreting the Contract Documents so as to accomplish the purposes described.
   b. Carrying out the execution of the work.
   c. Modifications of, and additions to, the details as may be required to fulfill the intent of the Contract Documents.
   d. Maintaining the design/control/operation concepts as described in the Contract Documents.
2. 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.

I. Painting And Touch Up

1. The Sound, Video & Communication Contractor shall be responsible for painting all Sound, Video & Communication Systems equipment and components exposed to view and shall

also be responsible for the correction of minor cosmetic damage so that all Sound, Video & Communication Systems 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.

J. Cleanup

1. In addition to the requirements outlined in the General Conditions, leave work areas clean and in proper order at the end of each workday. Coordinate with Owner's performance and rehearsal schedule, as required.

K. Omissions And/Or Errors

1. Omissions and/or errors within the Contract Documents shall not relieve this Subcontractor of the responsibility for providing a properly functioning installation of the Sound, Video & Communication Systems as outlined in "PART 2 – PRODUCTS".

L. Safety And Code Requirements

1. The Sound, Video & Communication Systems equipment, material, arrangements, and procedures shall conform to the applicable local building, electrical and safety codes in the City of Orlando 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 Sound, Video & Communication systems 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.

1.7 SUBMITTALS

A. Project Timetable

1. Submit a Sound, Video & Communication Systems project timetable for approval, after consultation with the Construction Manager 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, final test report submittal and approval, operating manual and as-built documentation submittal and approval, demonstration and instruction, and project completion.
3. Be aware of the following when preparing the project timetable:
   a. The Consultant shall be allowed at least fourteen (14) days for review of each submittal.
   b. Each submittal shall be revised and resubmitted as required by the Consultant.
   c. The Consultant reserves the right to modify or disapprove the submittal list or timetable.

B. Pre-Submittal Meeting

1. The Sound, Video & Communication Subcontractor shall meet with the Construction Manager 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 Sound, Video & Communication Subcontractor 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. The SVCC should expect to attend regular coordination meetings at the site for the full duration of the Project as part of this Contract.

C. Shop Drawings

1. Contractor Submission
   a. Submit, through the Construction Manager as specified in the General Conditions, 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.
   b. This submittal shall include the following:
      1) Block diagrams (indicating all equipment interconnection and wiring).
      2) Schematic diagrams of custom circuitry and equipment.
      3) Equipment rack layouts.
      4) Patch panel layouts (including full-scale drawings of all patch panel labels).
      5) Connector pinouts.
      6) Custom receptacle plate, combination panel, and stage manager console layouts (full scale drawings required).
      7) Custom mounting brackets.
      8) Mounting conditions and methods for all devices.
      9) Wiring distribution diagrams and wire pulling schedules.
      10) Detail drawings as required.
   c. Submit names of the original equipment manufacturers or other suppliers, the specific model numbers of all Sound, Video & Communication Systems components, appropriate OEM catalog sheets, and technical data sheets. Submit also detailed descriptions of any required modifications to the specified equipment.
   d. Submit a complete, itemized list of all equipment and material that shall be provided as part of the Sound, Video & Communication Systems. 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.
   e. 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. Requests for electronic files of contract drawings shall be denied.
   f. 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.
2. Consultant Review
   a. The shop drawings shall be reviewed by the Consultant and shall be approved before the Sound, Video & Communication Subcontractor begins fabrication and installation of any aspect of the Sound, Video & Communication Systems. 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 Subcontractor with a satisfactory review status shall be used in the execution of this Section.

b. Non-conformities and errors detected during the shop drawing review shall be noted on the drawings and returned to the Sound, Video & Communication Contractor upon completion of the review. The Subcontractor is responsible for the completeness and accuracy of the shop drawings.
c. 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.
d. 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 Subcontractor of the sole responsibility to provide an installation adhering strictly to the requirements of the Contract Documents.
e. Shop drawing review does not include engineering calculations by the Consultant unless expressly indicated on the drawings.

3. Samples And Mock-Ups
   a. 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:
      1) A typical wall receptacle plate, with connector and engraved legend (e.g., an "IRE" plate).
      2) A 300mm x 300mm (12" x 12") section of a typical combination panel, with one (1) sample of each type of scheduled connector, and sample engraved legends.
      3) Factory or custom finishes for equipment racks, cabinets, blank and vent rack panels, and communication control panels and pendants.
      4) All cloth and/or metal grille material, with integral framing or support construction where appropriate.
      5) Custom paint samples for Sound, Video & Communication Systems 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.
4. Record Drawings
   a. 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.
   b. 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.
   c. 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 Subcontractor.
   d. After review by the Consultant, make any required revisions to the record drawings until the contents are satisfactory to the Consultant.
5. Operating Manual
   a. Provide four (4) copies of operating manuals. 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 (often referred to as "sheet protectors"). Include the following items:

1) Title sheet labeled "Sound, Video & Communication Systems—Operating Manual", project name, and date.
2) Table of contents.
3) Names, addresses, and phone numbers of Sound, Video & Communication Contractor, sub-Contractors, and suppliers.
4) Final version of the equipment list.
5) System description.
6) Operating instructions.
7) Periodic maintenance procedures.
8) List of all spare parts and equipment.
9) Complete OEM data sheets, operating manuals, service manuals, and related documentation.
10) Storage media (CD/DVD) containing purchased software, backed-up downloaded software, and digital signal processor software final configuration.
11) Block and schematic diagrams of all systems.
12) Plugging key plan, showing wiring and receptacles (i.e., a quick-reference chart of combination panels, wall receptacles, and patching only).
13) Device, wiring, termination, and hardware schedules.
14) List of equipment design parameters including safe working capacities, maximum simultaneous operations, and similar information.
15) Maintenance instructions for finished surfaces and material.
16) The Final Test Report (see below).

b. 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."

c. After review by the Consultant, make any required revisions to the Operating Manual until the contents are satisfactory to the Consultant. Four (4) copies of the final approved version shall be supplied in accordance with the General Conditions.

6. Mounted Block Diagram

a. Provide a half-size (minimum) print of each Sound, Video & Communication Systems block diagram in each corresponding control room and equipment rack room. Mount each diagram in a glass enclosed frame and securely mount in each control/rack room adjacent to the equipment racks. Block diagrams shall be of approved record drawings.

1.8 COMMISSIONING

A. Testing And Adjustment

1. Perform tests and adjustments to the Sound, Video & Communication Systems at the project milestones indicated below, and as specifically outlined in "PART 3 - EXECUTION: Testing and Adjustment."

B. Interim Shop Inspection

1. Demonstrate the functions of all major systems, equipment, assemblies, and subassemblies of the Sound, Video & Communication Systems in the shop or factory no later than four (4) months prior to project completion. Perform all tests and demonstrations in the

presence of the Consultant. The systems, equipment, and components that shall be demonstrated include, but are not necessarily limited to, the following:

a. Sound System mixing consoles, with associated portable signal processing racks and cabling.
b. Sound System equipment racks (for Sound Control Room, and Amplifier Rack Room).
c. Stage Manager's Consoles, and associated extension cables.
d. Communication System equipment racks (for Communication Rack Room).

2. 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.
3. 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 (refer to PART 3 – EXECUTION: Testing and Adjustment). This shall occur after substantial completion of the Sound, Video & Communication Systems, 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 and operational in every respect, and that the Sound, Video & Communication Systems are ready for the final site inspection.

D. Final Site Inspection

1. Upon approval of the initial test report, the Sound, Video & Communication Subcontractor shall notify the Construction Manager 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 Sound, Video & Communication Systems, 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 Inspection, proceed with the measurement and optimization of the performance loudspeaker systems as described in PART 3 –

EXECUTION: Testing and Adjustment. This Subcontractor shall have arranged for and scheduled rental of a complete Meyer Sound Laboratories SIM3 multi-channel measurement system and shall have subcontracted a Consultant-approved SIM3 operator (Bob McCarthy [bob@bobmccarthy.com] or Andrew Hope [andrew@gerr.com] preferred) who will conduct the actual measurements and supervise the optimization of these systems with the Consultant. This measurement process shall be scheduled for a period of three (3) consecutive days for the Music Hall. Ensure that no other work is scheduled in the audience chambers or stage areas 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 sound system equipment and to perform the various corrective tasks that are revealed during this procedure, including rigging adjustments and polarity correction. Provide any relevant backup or spare equipment including loudspeaker drivers, amplifier modules and software/computer spares. 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. Final Test Report

1. After completion of the final site inspection and loudspeaker 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 Sound, Video & Communication Systems 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. The final test report shall include updated results from the initial test report, printouts of the SIM3 measurement plots showing pre and post optimization, and hardcopy of final digital signal processor configurations and delay and equalization values.

G. 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 sixteen (16) hours. This instruction shall include:
   a. Operating procedures for proper use of all systems.
   b. Proper maintenance of all systems.
   c. Replacement procedures for user replaceable parts.
2. 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 recorded to digital video by this Contractor (or other format as directed by the Owner). One set of DVD's shall be submitted to the Owner within one (1) week following the recording.
3. Instruction shall be by qualified expert operators who have actual experience with the system in performance conditions. Submit instructors' qualifications to the Consultant at least two (2) weeks prior to the demonstration and instruction session. Should the Consultant find this Contractor's instruction personnel lacking in qualifications, the instruction sessions shall be rescheduled with new instructor(s), also pre-approved by the Consultant.

4. As a portion of this instruction, present the final, approved version of the Operating Manual to the Owner, Construction Manager 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.

H. Guarantee And Warranties

1. General
   a. Furnish the Owner with a written warranty in accordance with General Conditions, covering all engineering, equipment, material, and installation workmanship incorporated into the work of this Section, until two (2) years 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.
   b. In the absence of a maintenance and service contract (outlined below), honor all extended warranties provided by original equipment manufacturers beyond the two (2) year guarantee outlined above. The Sound, Video & Communication 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 after the first year.
4. Follow-Up Testing and Adjustment
   a. Provide technicians to test and adjust the Sound, Video & Communication Systems, 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.
6. Maintenance And Service Contract
   a. 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 Sound, Video & Communication Systems. This service contract may be provided directly by this Contractor or through an approved local or regional service center.
   b. 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 "loaner" equipment, replacement of parts, and a regular maintenance program for all equipment in the Sound, Video &

Communication Systems. The service contract shall specify a guaranteed response time.

PART 2 - PRODUCTS

2.1 Equipment and Material

1. All equipment and material shall be new, of the highest quality appropriate to the application and of uniform appearance throughout the system. Only equipment and materials from established original equipment manufacturers of sound and communication equipment shall be used. Components shall be commonly available and field replaceable, where possible.
2. All equipment and component enclosures shall be welded or tightly fitted assemblies of sheet steel with angles, channels and tees forming rigid frames for support of outer cabinetwork and internal components. Construction with anodized aluminum is acceptable only where specified.
3. Unless otherwise stated, all rack-mounted electronic and electrical equipment and components shall conform to EIA 19" standard. Any devices not specifically designed to be rack mountable shall be adapted, by professionally acceptable methods, to meet the EIA standard.
4. The rack height of all equipment and components noted in this specification is in 1.75" (44mm) units, or spaces. (i.e., a 5.25" device, that is three rack spaces high = "3U").

2.2 Equipment

Continued on Next Page

	description	mfr	model	qty
	AUDITORIUM			
A	*Mixing System - Auditorium*			
1	F-XLR Stage Box to M-XLR Tails, 12ch , 50'	Whirlwind	ME-12-M-NR-50	1
2	Digital Mixing Console System, 48kHz,	Midas	Midas M32R	1
3	Console fixed format I/O, 32 Analog ip, 16 Analog op, 4 AES op	Midas	DL32	1
4	Console fixed format I/O, 16 Analog ip, 8 Analog op	Midas	DL16	1
5	2U Rack for DL16	Gator	G-Tour 2U	1
6	Rack Mounted Analog Mixer	ART	MX622	2
7	iPad Air 2, 32GB, WiFi, w/ Apple SmartCase	Apple	iPad Air 2 32GB WiFi	1
8	WiFi Router	Apple, equal	Airport Extreme	1
B	*Main Loudspeaker System - Auditorium*			
1	Main Loudpeaker Array	d&b audiotechnik	Yi10P	2
2	Main Loudspeaker Array Frame	d&b audiotechnik	Yi10P Horiz Brkt	1
3	Proscenium Side Loudspeaker - Lower	d&b audiotechnik	E12-D	2
4	Proscenium Side Loudspeaker - Upper	d&b audiotechnik	E12	2
5	Custom #12 NL2 Cables for Permanent Loudspeakers	Whirlwind	$500 Allowance	1
6	Miscellaneous Rigging Materials incl Safeties for all Loudspeakers	Custom	$2,000 Allowance	1
7	4-Ch Power Amplifier w/ DSP Processing	d&b audiotechnik	30D	2
C	*Self-powered Portable Monitor/Effects Loudspeakers*			
1	Self-powered Monitor Loudspeaker - Large	Yamaha	DXR10	2
D	*Wireless Microphones*			
1	UHF Combo Wireless Mic System Recvr/Handheld/Bodypack	Sennheiser	EW312/335G3-A	2
2	UHF Wireless Mic System Recvr/Handheld Tx	Sennheiser	EW335G3-A	2
3	Active Antenna Splitter for 4 Receivers, incl PSU & 2 Antenna	Sennheiser	G3OMNIKIT4	1
4	Rechargeable Battery Pack for Handheld & Bodypack Tx	Sennheiser	BA2015	6
5	Dual Drop-In Charger for Handheld & Bodypack Tx	Sennheiser	L2015	3
6	PSU for up to 3 L2015	Sennheiser	NT3-1US	1
7	Handheld Tx Charger Adapter	Sennheiser	LA2	6
8	Miscellaneous Rigging Materials for Antenna Mounting	Sennheiser	$100 Allowance	1
E	*Wired Microphones & Direct Boxes*			
1	Handheld, dynamic Microphone	Shure	SM-58LC	6
2	Handheld, dynamic Microphone w/switch	Shure	SM-58S	1
3	Dynamic Instrument Microphone	Shure	SM-57LC	4
4	Condenser Instrument Microphone, cardioid	Shure	SM-81LC	4

	description	mfr	model	qty
5	Condenser Recording Microphone, cardioid, Matched Pair	Neumann	SKM 184 ni	1
6	Hanging Chorus Microphone	DPA	SC4098-BM15	4
7	Direct Box, Jensen, single-ch	Radial	JDI	2
8	Direct Box, Jensen, PC/iPod	Radial	JPC	1
9	Instrument Cable, 10'	Whirlwind	SN10	2
10	iPod Cable, 3.5mm Stereo>2x M-XLR, 6'	Whirlwind	MST2XM06US	2
F	*Microphone Stands*			
1	Microphone Stand, Round Base, Black	K&M	260/1	2
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	1
5	Microphone Boom Arm	K&M	211/1	4
6	Microphone Clamp	K&M	238	2
7	Microphone Holder	K&M	240/5	2
8	Microphone Desk Stand, Black	Atlas	DS7E	4
9	Microphone Stand Crate	Custom	$500 Allowance	1
G	*Portable Microphone Cable*			
1	Microphone Cable, Canare/Neutrik, 10'	Whirlwind	MK410NP	4
2	Microphone Cable, Canare/Neutrik, 25'	Whirlwind	MK425NP	12
3	Microphone Cable, Canare/Neutrik, 50'	Whirlwind	MK450NP	8
4	Microphone Cable, Canare/Neutrik, 100'	Whirlwind	MK4100NP	4
H	*Wired Intercom System*			
1	Intercom Main Station, 2ch	ClearCom	PS-702	1
2	Intercom Beltpack, 1ch	ClearCom	RS-701	4
3	Intercom Wall Station, 4-Gang, 2ch	ClearCom	KB-702	2
4	Intercom Handset	ClearCom	HS-6	2
5	Intercom Headset, Single muff	ClearCom	CC-300-X4	4
I	*Assistive Listening System*			
1	FM Assistive Listening System, w/transmitter, 4 receivers	Listen	LS-17-072	1
2	Receiver, digital	Listen	LR500	8
3	Charging case, for 4 receivers	Listen	LA-317-01	3
4	Rechargeable battery	Listen	LA-362	12
5	Neck loop, for telecoils	Listen	LA166	2
6	Ear Buds	Listen	LA-161	12
J	*Audio Program Monitor System*			
1	House Microphone	Shure	VP82	1
2	Microphone Mounting Hardware, Allowance	Custom	$50 Allowance	1
3	Portable Phantom Power Supply	Samson	S-Phantom	1
4	4-Zone 70v Mixer/Amplifier w/ Rack Kit	TOA	MA-725F	1
5	Ceiling loudspeaker w/ integral back can, 70V transformer	Tannoy	CVS6	17
6	Volume control, 70V, 35W	Atlas Sound	AT35D	5

	description	mfr	model	qty
K	*Equipment Rack, Portable Equipment Storage Cabinet*			
1	Equipment Rack	MiddleAtlantic	BGR-4532-SA-LRD	2
2	Rack Top, vented	MiddleAtlantic	BGR-LVT	2
3	Rear door, with cable entry	MiddleAtlantic	BGR-RDC45	2
4	Cable Lacer Bars - 10pk	MiddleAtlantic	LBP-1.5	2
5	Vent Panels – As Required	MiddleAtlantic	$100 Allowance	1
6	Blank Panels – As Required	MiddleAtlantic	$100 Allowance	1
7	1sp Brush Panel	Middle Atlantic	BR1	2
8	3U Rack Drawer w/ Lock	MiddleAtlantic	TD3LK	4
9	Rack Panel Screws	MiddleAtlantic	HP500	1
10	TechFlex, 1.25"-2.75" expandable tubing	TechFlex	PET8-50-BK	1
11	Rack Mount power Conditioner	Furman	PL-PRO C	4
12	Internal Rack Work Light	MiddleAtlantic	WL60	2
13	Cable Management, in rack, vertical cable tray	Hellerman, equal	2x2, 3x3	1
14	Storage Cabinet w/ 6 Shelves, 48"w x 19"d x 72"h	McMaster Carr	4775T71	1
15	48 Port Gigabit Netowrk Switch	Hewlwtt Packard	TBD	1
16	24 Port Gigabit Network Switch	Hewlett Packard	TBD	1
L	*Custom Panels, Patch Panels*			
1	Custom Panel, laser-etched, black aluminum	WW Custom	C01	1
2	Custom Panel, laser-etched, black aluminum	WW Custom	C02	1
3	Custom Panel, laser-etched, black aluminum	WW Custom	C03	1
4	Floorbox incl: FMCA2200, MPK, MPR, BB200D	Mystery Elec	C04	1
5	Floorbox incl: FMCA2200, MPK, MPR, BB200D	Mystery Elec	C05	1
6	Floorbox incl: FMCA2200, MPK, MPR, BB200D	Mystery Elec	C06	1
7	Custom Panel, laser-etched, black aluminum	WW Custom	C07	1
8	Custom Panel, laser-etched, black aluminum	WW Custom	C08	1
9	Floorbox incl: FMCA2200, MPK, MPR, BB200D	Mystery Elec	C09	1
10	Custom Panel, laser-etched, black aluminum	WW Custom	C10	1
11	Custom Panel, laser-etched, black aluminum	WW Custom	C11	1
12	Custom Panel, laser-etched, black aluminum	WW Custom	C12	1
13	Custom Panel, laser-etched, black aluminum	WW Custom	C13	1
14	Custom Panel, laser-etched, black aluminum	WW Custom	C14	1
15	Custom Panel, laser-etched, black aluminum	WW Custom	C15	1
16	Custom Panel, laser-etched, black aluminum	WW Custom	C16	1
17	Custom Panel, laser-etched, black aluminum	WW Custom	C17	1
18	Custom Panel, laser-etched, black aluminum	WW Custom	C18	1
19	Custom Panel, laser-etched, black aluminum	WW Custom	C19	1
20	Custom Panel, laser-etched, black aluminum	WW Custom	C20	1
21	Custom Panel, laser-etched, black aluminum	WW Custom	C21	1

	description	mfr	model	qty
22	Custom Panel, laser-etched, black aluminum	WW Custom	C22	1
23	Custom Panel, laser-etched, black aluminum	WW Custom	C23	1
24	Custom Panel, laser-etched, black aluminum	WW Custom	C24	1
25	Custom Panel, laser-etched, black aluminum	WW Custom	C25	1
26	Custom Panel, laser-etched, black aluminum	WW Custom	C26	1
27	Custom Panel, laser-etched, black aluminum	WW Custom	'S1'	20
28	Custom Panel, laser-etched, black aluminum	WW Custom	'MV'	4
29	Custom Panel, laser-etched, black aluminum	WW Custom	"Mic Patch"	1
30	Custom Panel, laser-etched, black aluminum	WW Custom	"Line Patch"	1
31	Custom Panel, laser-etched, black aluminum	WW Custom	"Speaker Patch"	1
32	Custom Panel, laser-etched, black aluminum	WW Custom	"Video Patch"	2
33	Custom Panel, laser-etched, black aluminum	Leviton	"CAT6 Patch"	1
M	*Bulk Cable, Pre-Made Cables*			
1	A1 - Microphone cable, 1pr - 1000'	Belden	9451	LOT
2	A2 - Microphone cable, 2pr - 1000'	Belden	1509C	LOT
3	A4 - Microphone cable, 4pr - 1000'	Belden	1510C	LOT
4	D1 - 75ohm RG-6/U Low Loss Coaxial Cable - 1000'	Belden	1694A	LOT
5	D2 - 50ohm RG-8/U Coaxial Cable - 1 Foot	Belden	9914	LOT
6	D3 - 4x23 AWG Twisted Pair, CAT6 - 1000'	West Penn	4246	LOT
7	E1 - 20 AWG Twisted Pair, Mylar Shield-1000'	West Penn	292	LOT
8	F1 - 2x 12 AWG Stranded Copper w/ PVC Jacket - 1000'	Belden	5000UP	LOT
9	F2 - 4x 12 AWG Stranded Copper w/ PVC Jacket - 1000'	Belden	5002	LOT
10	G1 - 2x 14 AWG Stranded Copper w/ PVC Jacket - 1000'	West Penn	226	LOT
11	LOT, Pre-made Cables for all Interconnect	Custom	$1,000 Allowance	1
12	LOT, Pre-made Cables for all Patching	Custom	$500 Allowance	1
N	*Projection Screen*			
1	16:10 Fixed Frame Projection Screen w/ Pro Masking Border Accessory	Da-Lite	Series 200 Lace & Grommet; 108"x192"	1
O	*Video Projection System – N.I.C. (FF&E)*			
1	7000 lm WUXGA Laser Video Projector	Panasonic	PT-RZ770	1
2	Mount for Projector	TBD	$500 Allowance	1
3	HDMI/VGA > HDBaseT Transmitter Wall Plate	Atlona	AT-HDVS-150-TX-WP	3
4	HDBaset-T/HDMI 8x4 Video Switcher	Atlona	AT-UHD-CLSO-824	1
5	Dual 7" HD Rack Mount Video Monitor	ELVID	SRM-7X2-LT	1
6	CD/BLU-Ray Player	Denon	DN-500BD	1
7	Apple TV; 32GB	Apple	Apple TV	1
8	iPad-based Remote Control Gateway	Global Cache	GC-100-19	1

	description	mfr	model	qty
P	*Wireless Intercom System – N.I.C. (FF&E)*			
1	2.4GHz Wireless Intercom System, 4 Users incl. Headsets	HME	CZ11432	1
Q	*PROJECT ADD ALT #33 - HD Video Camera & Recorder*			
1	HDMI Camera, w/1/4.37 CMOS sensor	Panasonic	AW-HE2P/E	1
2	Desktop Remote Control for Video Camera	Panasonic	AW-RP50	1
3	Compact Live Video Switcher	Panasonic	AW-HS50N	1
4	HDMI CAT6 Extender Transmitter/Receiver	Atlona	AT-UHD-EX-70C-KIT	1
5	SDI>HDMI Converter	AJA	ROI-SDI	1
6	HD SDI Dual Hard Disc Recorder	Blackmagic Design	Hyperdeck Studio 2	1
7	480GB SATA Hard Disk for Hyperdeck Studio	SanDisk	480GB Ultra II	1
8	SATA Disk USB Dock	Xcellon	HDD-01 Sata	1
9	Rack Audio Monitor	Fostex	RM3	1
10	12x12 HD-SDI Video Router	Blackmagic Design	Smart Videohub	1
11	Misc Pre-Made Cables	Custom	$200 Allowance	1
D	*Portable Wireless Microphones – N.I.C. (FF&E)*			
1	UHF Combo Wireless Mic System Recvr/Bodypack/ MKE2ew Lavalier Mic	Sennheiser	EW512G3-A1-US	20
3	Active Antenna Splitter for 4 Receivers, incl PSU & 2 Antenna	Sennheiser	G3OMNIKIT4	1
3	Active Antenna Splitter for 8 Receivers, incl PSU & 2 Antenna	Sennheiser	G3OMNIKIT8	2
4	Rechargeable Battery Pack for Handheld & Bodypack Tx	Sennheiser	BA2015	20
5	Dual Drop-In Charger for Handheld & Bodypack Tx	Sennheiser	L2015	10
6	PSU for up to 3 L2015	Sennheiser	NT3-1US	4
7	Miscellaneous Rigging Materials for Antenna Mounting	Sennheiser	$500 Allowance	1
8	16U Portable Equipment Rack w/ Power Mod	EWI	R16U	1
	STUDIO THEATRE			
AA	*Equipment Rack, Portable Equipment Storage Cabinet*			
1	Equipment Rack	MiddleAtlantic	BGR-4532-SA-LRD	2
2	Rack Top, vented	MiddleAtlantic	BGR-LVT	2
3	Rear door, with cable entry	MiddleAtlantic	BGR-RDC45	2
4	Cable Lacer Bars - 10pk	MiddleAtlantic	LBP-1.5	2
5	Vent Panels – As Required	MiddleAtlantic	$100 Allowance	1
6	Blank Panels – As Required	MiddleAtlantic	$100 Allowance	1
7	1sp Brush Panel	Middle Atlantic	BR1	4
8	3U Rack Drawer w/ Lock	MiddleAtlantic	TD3LK	4
9	Rack Panel Screws	MiddleAtlantic	HP500	1

	description	mfr	model	qty
10	TechFlex, 1.25"-2.75" expandable tubing	TechFlex	PET8-50-BK	1
11	Rack Mount power Conditioner	Furman	PL-PRO C	4
12	24 Port Gigabit Network Switch	Hewlett Packard	TBD	1
12	Internal Rack Work Light	MiddleAtlantic	WL60	2
13	Cable Management, in rack, vertical cable tray	Hellerman, equal	2x2, 3x3	1
BB	*Custom Panels, Patch Panels*			
1	Custom Panel, laser-etched, black aluminum	WW Custom	C51	1
2	Custom Panel, laser-etched, black aluminum	WW Custom	C52	1
3	Custom Panel, laser-etched, black aluminum	WW Custom	C53	1
4	Custom Panel, laser-etched, black aluminum	WW Custom	C54	1
5	Custom Panel, laser-etched, black aluminum	WW Custom	C55	1
6	Custom Panel, laser-etched, black aluminum	WW Custom	C56	1
7	Custom Panel, laser-etched, black aluminum	WW Custom	C57	1
8	Custom Panel, laser-etched, black aluminum	WW Custom	C58	1
9	Custom Panel, laser-etched, black aluminum	WW Custom	C59	1
10	Custom Panel, laser-etched, black aluminum	WW Custom	C60	1
11	Custom Panel, laser-etched, black aluminum	WW Custom	"Mic Patch"	1
12	Custom Panel, laser-etched, black aluminum	WW Custom	"Line Patch"	1
13	Custom Panel, laser-etched, black aluminum	WW Custom	"Speaker Patch"	1
14	Custom Panel, laser-etched, black aluminum	Leviton	"CAT6 Patch"	1
CC	*Bulk Cable, Pre-Made Cables*			
1	A1 - Microphone cable, 1pr - 1000'	Belden	9451	LOT
2	A2 - Microphone cable, 2pr - 1000'	Belden	1509C	LOT
3	A4 - Microphone cable, 4pr - 1000'	Belden	1510C	LOT
4	D1 - 75ohm RG-6/U Low Loss Coaxial Cable - 1000'	Belden	1694A	LOT
5	D3 - 4x23 AWG Twisted Pair, CAT6 - 1000'	West Penn	4246	LOT
6	E1 - 20 AWG Twisted Pair, Mylar Shield-1000'	West Penn	292	LOT
7	F1 - 2x 12 AWG Stranded Copper w/ PVC Jacket - 1000'	Belden	5000UP	LOT
8	F2 - 4x 12 AWG Stranded Copper w/ PVC Jacket - 1000'	Belden	5002	LOT
9	LOT, Pre-made Cables for all Interconnect	Custom	$500 Allowance	1
10	LOT, Pre-made Cables for all Patching	Custom	$250 Allowance	1
DD	*PROJECT ADD ALT #30 [All Remaining Items in this Section]*			
	Mixing System			
1	F-XLR Stage Box to M-XLR Tails, 12ch , 50'	Whirlwind	ME-12-M-NR-50	1
2	Digital Mixing Console System, 48kHz,	Behringer	X32 Rack	1
3	Console fixed format I/O, 16 Analog ip, 8 Analog op	Midas	DL16	1
4	2U Rack for DL16	Gator	G-Tour 2U	1
5	SDI>HDMI Converter	AJA	ROI-SDI	1
6	WiFi Router	Apple, equal	Airport Extreme	1

	description	mfr	model	qty
7	Console Self-powered Monitor Loudspeakers, Pair	AudioEngine	A2	1
8	Dual 7” HD Rack Mount Video Monitor	ELVID	SRM-7X2-LT	1
	Main Loudspeaker System			
1	Main Loudspeaker	d&b audiotechnik	E12-D	4
2	Custom #12 NL2 Cables for Permanent Loudspeakers	Whirlwind	$500 Allowance	1
3	Miscellaneous Rigging Materials incl Safeties for all Loudspeakers	Custom	$1000 Allowance	1
4	4-Ch Power Amplifier w/ DSP Processing	d&b audiotechnik	30D	1
	Self-powered Portable Monitor/Effects Loudspeakers			
1	Self-powered Monitor Loudspeaker - Large	Yamaha	DXR10	2
	Wireless Microphones			
1	UHF Wireless Mic System Recvr/Handheld Tx	Sennheiser	EW335G3-A	2
2	Active Antenna Splitter for 2 Receivers, incl PSU & 2 Antenna	Sennheiser	G3OMNIKIT4	1
3	Rechargeable Battery Pack for Handheld & Bodypack Tx	Sennheiser	BA2015	2
4	Dual Drop-In Charger for Handheld & Bodypack Tx	Sennheiser	L2015	1
5	PSU for up to 3 L2015	Sennheiser	NT3-1US	1
6	Handheld Tx Charger Adapter	Sennheiser	LA2	2
7	Miscellaneous Rigging Materials for Antenna Mounting	Sennheiser	$100 Allowance	1
	Wired Microphones & 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	1
	Microphone Stands			
1	Microphone Stand, One-hand clutch, stackable, Black	K&M	26075	4
2	Microphone Boom Arm	K&M	211/1	2
3	Microphone Clamp	K&M	238	2
4	Microphone Holder	K&M	240/5	2
5	Microphone Stand Crate	Custom	$200 Allowance	1
	Portable Microphone Cable			
1	Microphone Cable, Canare/Neutrik, 10'	Whirlwind	MK410NP	2
2	Microphone Cable, Canare/Neutrik, 25'	Whirlwind	MK425NP	10
3	Microphone Cable, Canare/Neutrik, 50'	Whirlwind	MK450NP	4

	description	mfr	model	qty
	Assistive Listening System			
1	FM Assistive Listening System, w/transmitter, 4 receivers	Listen	LS-17-072	1
2	Charging case, for 4 receivers	Listen	LA-317-01	1
3	Rechargeable battery	Listen	LA-362	4
4	Neck loop, for telecoils	Listen	LA166	2
5	Ear Buds	Listen	LA-161	4
	Wired Intercom System			
1	Intercom Main Station, 2ch	ClearCom	PS-702	1
2	Intercom Beltpack, 1ch	ClearCom	RS-701	4
3	Intercom Headset, Single muff	ClearCom	CC-300-X4	4
	Audio Program Monitor System			
1	House Microphone	Shure	VP82	1
2	Microphone Mounting Hardware, Allowance	Custom	$50 Allowance	1
3	Portable Phantom Power Supply	Samson	S-Phantom	1
	Wireless Intercom System			
1	2.4GHz Wireless Intercom System, 4 Users incl. Headsets	HME	CZ11432	1
	HD Video Camera & Recorder			
1	HDMI Camera, w/1/4.37 CMOS sensor	Panasonic	AW-HE2P/E	1
2	Desktop Remote Control for Video Camera	Panasonic	AW-RP50	1
3	Compact Live Video Switcher	Panasonic	AW-HS50N	1
4	HDMI CAT6 Extender Transmitter/Receiver	Atlona	AT-UHD-EX-70C-KIT	1
5	HDBasetT > HD SDI Converter	AJA	HB-R-SDI	1
6	HD SDI Dual Hard Disc Recorder	Blackmagic Design	Hyperdeck Studio 2	1
7	480GB SATA Hard Disk for Hyperdeck Studio	SanDisk	480GB Ultra II	1
8	SATA Disk USB Dock	Xcellon	HDD-01 Sata	1
9	Rack Audio Monitor	Fostex	RM3	1
10	12x12 HD-SDI Video Router	Black Magic Design	Smart Videohub	1
11	Misc Pre-Made Cables	Custom	$200 Allowance	1
	GYMNASIUM			
PP	*Mixing System*			
1	F-XLR Stage Box to M-XLR Tails, 6ch , 75'	Whirlwind	ME-6-M-NR-75	1
2	Digital Mixing Console System, 48kHz,	Behringer	X32 Rack	1
3	iPad Air 2, 32GB, WiFi, w/ Apple SmartCase	Apple	iPad Air 2 32GB WiFi	1
4	WiFi Router	Apple, equal	Airport Extreme	1
QQ	*Overhead Loudspeaker System*			
1	Surface Ceiling Loudspeaker incl. 2 Spare	SoundTube	HP890i-WH	24
2	Surface Mount Bracket for Loudspeaker	SoundTube	AC-RS-SM8-WH	24
3	Miscellaneous Rigging Materials incl Safeties for all Loudspeakers	Custom	$500 Allowance	1
4	4-Ch 70v Power Amplifier	LabGruppen	C48:4	2
5	100 Watt 70v Volume Control	Atlas	AT100D	7

	description	mfr	model	qty
RR	*Wireless Microphones*			
1	UHF Wireless Mic System Recvr/Handheld Tx	Sennheiser	EW335G3-A	2
2	Active Antenna Splitter for 2 Receivers, incl PSU & 2 Antenna	Sennheiser	G3OMNIKIT4	1
3	Rechargeable Battery Pack for Handheld & Bodypack Tx	Sennheiser	BA2015	2
4	Dual Drop-In Charger for Handheld & Bodypack Tx	Sennheiser	L2015	1
5	PSU for up to 3 L2015	Sennheiser	NT3-1US	1
6	Handheld Tx Charger Adapter	Sennheiser	LA2	2
7	Miscellaneous Rigging Materials for Antenna Mounting	Sennheiser	$100 Allowance	1
8	50’ RG-8 50 ohm Antenna Cable	Sennheiser	50’ RG-8	2
SS	*Wired Microphones & Direct Boxes*			
1	Handheld, dynamic Microphone	Shure	SM-58LC	2
2	Handheld, dynamic Microphone w/switch	Shure	SM-58S	2
3	Direct Box, Jensen, PC/iPod	Radial	JPC	1
4	iPod Cable, 3.5mm Stereo>2x M-XLR, 6'	Whirlwind	MST2XM06US	1
TT	*Microphone Stands*			
1	Microphone Stand, One-hand clutch, stackable, Black	K&M	26075	4
UU	*Portable Microphone Cable*			
1	Microphone Cable, Canare/Neutrik, 50'	Whirlwind	MK450NP	4
VV	*Equipment Rack, Portable Equipment Storage Cabinet*			
1	Equipment Rack	MiddleAtlantic	DWR-3522-VFD	1
2	1sp Rack Vent Panel	MiddleAtlantic	EVT-1	Lot
3	2sp Blank Panel	MiddleAtlantic	SB-2	Lot
4	1sp Brush Panel	Middle Atlantic	BR1	2
5	3U Rack Drawer w/ Lock	MiddleAtlantic	TD3LK	2
6	Rack Panel Screws	MiddleAtlantic	HP500	1
7	Rack Mount power Conditioner	Furman	PL-PRO C	2
8	1U Rack Shelf	Middle Atlantic	U1	1
WW	*Custom Panels, Patch Panels*			
1	Custom Panel, laser-etched, black aluminum	WW Custom	C71	1
2	Custom Panel, laser-etched, black aluminum	WW Custom	C72	1
3	Custom Panel, laser-etched, black aluminum	WW Custom	C73	1
4	Custom Panel, laser-etched, black aluminum	WW Custom	C74	1
5	Custom Panel, laser-etched, black aluminum	WW Custom	"MV"	1
6	Custom Panel, laser-etched, black aluminum	WW Custom	"D2"	1
	Custom Panel, laser-etched, black aluminum	WW Custom	"Volume Control"	1
XX	*Bulk Cable, Pre-Made Cables*			
1	A2 - Microphone cable, 2pr - 1000'	Belden	1509C	LOT
2	D3 - 4x23 AWG Twisted Pair, CAT6 - 1000'	West Penn	4246	LOT
3	F1 - 2x 12 AWG Stranded Copper w/ PVC Jacket - 1000'	Belden	5000UP	LOT
4	LOT, Pre-made Cables for all Interconnect	Custom	$500 Allowance	1

5	LOT, Pre-made Cables for all Patching	Custom	$250 Allowance	1
	description	*mfr*	*model*	*qty*
YY	*PROJECT ADD ALT #4 - Larger Gym [All Remaining Items in this Section]*			
	Digital Video Projection System			
1	Eletric Roll-Down Projection Screen 16:9, 176" x 312" w/ ##" Extra Drop	Da-Lite	38837 / Custom Drop	1
2	Screen Control	Da-Lite	$750 Allowance	1
3	13,500 lumen 1920x1080p Video Projector w/ ILS Lens TBD	Christie Digital	HD14K-M 1080 HD 3DLP	1
4	Ceiling Mount for Projector	TBD	$1,500 Allowance	1
5	HDMI/VGA > HDBaseT Transmitter Wall Plate	Atlona	AT-HDVS-150-TX-WP	3
6	HDBaset-T/HDMI 8x4 Video Switcher	Atlona	AT-UHD-CLSO-824	1
7	Dual 7" HD Rack Mount Video Monitor	ELVID	SRM-7X2-LT	1
8	CD/BLU-Ray Player	Denon	DN-500BD	1
9	Apple TV; 32GB	Apple	Apple TV	1
10	iPad-based Remote Control Gateway	Global Cache	GC-100-19	1
	Addl Loudspeakers			
1	Surface Ceiling Loudspeaker	SoundTube	HP890i-WH	6
2	Surface Mount Bracket for Loudspeaker	SoundTube	AC-RS-SM8-WH	6
	ONE-TOUCH RECORDING SYSTEMS [Rm C210B & B106]			
Q	*One-Touch Processor Kit*			
1	Streaming Media Processor	Extron	StudioStation 100	2
2	Remote Control Panel	Extron	RCP 101 EU	2
3	Two-Gang Surface Mount Box for Remote	Extron	SMB212	2
3	Remote Device Power Controller	Extron	IPL T PC1	2
4	Miscellaneous Rigging & Materials	TBD	$250 Allowance	2
5	Bulk & Pre-Made Cable for Camera	TBD	$250 Allowance	2
6	Wall Mount Rack w/ Accessories	TBD	$650 Allowance	2
7	3U Rack Drawer w/ Lock	MiddleAtlantic	TD3LK	2
8	Rack Mount Dual HDMI Monitor	Elvid	SRM-7X2-LT	2
R	*Video Camera*			
1	HDMI Camera, w/1/4.37 CMOS sensor	Panasonic	AW-HE2P/E	2
2	Handheld Remote for Video Camera	Panasonic	AW-RM50G	2
3	Miscellaneous Rigging & Materials	Custom	$100 Allowance	2

4	Bulk & Pre-Made Cable for Camera	TBD	$400 Allowance	2
	description	*mfr*	*model*	*qty*
S	*Microphones & Mixing*			
1	Room Mic	Shure	SM58	2
2	Microphone Desk Stand, Black	Atlas	DS7E	2
3	UHF Combo Wireless Mic System Recvr/Handheld/Bodypack	Sennheiser	EW312/335G3-A	2
4	Rechargeable Battery Pack for Handheld & Bodypack Tx	Sennheiser	BA2015	2
5	Dual Drop-In Charger for Handheld & Bodypack Tx	Sennheiser	L2015	2
6	PSU for up to 3 L2015	Sennheiser	NT3-1US	2
7	Handheld Tx Charger Adapter	Sennheiser	LA2	2
8	Rack Mounted Analog Mixer	ART	MX622	2
9	Bulk & Pre-Made Cable for Camera	TBD	$400 Allowance	2
T	*Custom Panels, Patch Panels*			
1	Custom Panel, laser-etched, black aluminum	WW Custom	MV	2
2	Custom Panel, laser-etched, black aluminum	WW Custom	M1	2
U	*Bulk Cable, Pre-Made Cables*			
1	A1 - Microphone cable, 1pr - 1000'	Belden	9451	LOT
2	D1 - 75ohm RG-6/U Low Loss Coaxial Cable - 1000'	Belden	1694A	LOT
3	D3 - 4x23 AWG Twisted Pair, CAT6 - 1000'	West Penn	4246	LOT
4	LOT, Pre-made Cables for all Interconnect	Custom	$500 Allowance	1
5	LOT, Pre-made Cables for all Patching	Custom	$250 Allowance	1

V	*HDTVs – N.I.C. (FF&E)*			
1	85" HDTV for Lobby	LG	SJ9750	2
2	43" HDTV for BOH Locations	LG	LJ550M	7
3	Wall Mount for 85" HDTV	Chief Mounts	XTM1U	2
4	Wall Mount for 42" HDTV	Chief Mounts	MTM1U	7
5	CAT6>HDMI Converter	BMD	MiniConverter SDI>HDMI	9
6	Misc Cable, Connectors & Hardware.	TBD	$400 Allowance	1

PART 3 - EXECUTION

3.1 QUALITY ASSURANCE AND WORKMANSHIP

A. The Sound, Video & Communication Contractor shall follow good working practices for the industry, 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.

B. Provide a properly qualified site supervisor who shall carry out supervision duties only.

C. Provide straight, plumb, true and aligned components throughout, and consult with other trades doing related work and adjoining work in order to provide an installation of first-class quality.

D. The Consultant reserves the right to reject any part of the installation not in compliance with the Contract Documents. The Sound, Video & Communication Contractor shall carry out any necessary remedial work or replacement free of charge and without delay to the Owner.

E. A standard set of reference guides for the design, engineering, and installation of the Sound and Communication Systems shall be:
1. Audio Systems Design and Installation, by Philip Giddings (Sams Publishing).
2. Sound Systems: Design and Optimization, by Bob McCarthy (Focal Press).
3. Video Systems in an IT Environment, by Al Kovalick (Focal Press).

F. Additionally, the following standards shall be used in the design, engineering and installation of the Sound and Communication Systems:
1. IEC 60065 Audio, video and similar electronic apparatus - Safety requirements
2. IEC 60268 Sound System Equipment
3. IEC 60574 Audio-visual, video and television equipment and systems
4. IEC 60942 Specification for Sound Calibration
5. IEC 60958 Serial Digital Audio Interconnect Standard
6. IEEE 1394 High-Speed "Daisy-Chained" Serial Interface for Digital Audio, Video, and Data Applications with Guaranteed Bandwidth or Latency
7. IEC 61883 Method for Transferring Data, Audio, Digital Video, and MPEG2 Data over IEEE 1394
8. IEC 60914 Conference Systems – Electrical and Audio Requirements
9. ISO 2603 Booths for Simultaneous Interpretation General Characteristics and Equipment
10. ISO/IEC 13818 Generic coding of moving pictures and associated audio information

3.2 DEFINITIONS

A. Electrical Reference
1. The following electrical references are used throughout the Sound, Video & Communication Systems specification:
   a. Voltage: dBv = $20\log(E_1/E_2)$
   b. Power: dB = $10\log(P_1/P_2)$
   c. 0dBu = 0.775VRMS; ratio of voltages measured open circuit
   d. 0dBv = 0.775VRMS; ratio of voltages measured open circuit
   e. 0dBV = 1.0VRMS; ratio of voltages measured open circuit
   f. 0dBm = 1mW; power level (typically 0.775V into 600-ohm load)

g. 0VU = +4dBm; power level referenced to 600 ohms

B. Electrical Characteristics
1. Unless otherwise specified in the Contract Documents, electrical characteristics of the Sound, Video & Communication Systems equipment shall be as follows:
   a. Microphone pre-amplifier inputs shall be balanced, have an impedance greater than or equal to 1.2kΩ, and be designed to be driven from sources of 600Ω or less.
   b. Line inputs shall be balanced bridging, have an impedance greater than or equal to 10kΩ, and be designed to be driven from sources of 10kΩ or less.
   c. Line outputs shall be balanced, have an impedance less than or equal to 100Ω, and designed to drive loads of 600Ω or greater.

C. Connector Polarity
1. 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:
   a. Polarity of connectors for OEM devices and equipment may be different, and should be wired to patch panels so as to maintain absolute polarity (e.g., if "pin 3" is high, connect to the patch panel "tip").
2. Microphone and Line Level
   a. Balanced Connection
      1) XLR-3 connectors: pin 1 = ground/shield (do not connect to case); pin 2 = high ("hot"); and pin 3 = low ("cold").
      2) Patch panel ("long frame") connectors: sleeve = ground/ shield; ring = low ("cold"); and tip = high ("hot").
      3) ¼" T/R/S phone connectors: sleeve = ground/shield; ring = low ("cold"); and tip = high ("hot").
   b. Unbalanced Connection
      1) 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.
      2) Patch panel ("long frame") insert connectors: sleeve = ground/common/shield; ring = input/return high ("hot"); and tip = output/send high ("hot"); unless otherwise noted by mixing console manufacturer.
      3) ¼" T/S phone connectors: sleeve = ground/common/shield; and tip = high ("hot").
      4) Phono (RCA) connectors: sleeve or shell = ground/common/ shield; and center pin = high ("hot").
   c. Multi-conductor Application
      1) Multi-pin connectors: Refer to the manufacturer's specifications.
3. Video and RF Level
   a. BNC-type connectors: sleeve or collar = ground/shield; and center pin = signal ("hot").
   b. F-type connectors: sleeve or collar = ground/shield; and center pin = signal ("hot").
4. UTP Level
   a. Refer to the manufacturer's specifications.
5. Intercom Level
   a. Production Intercom Line
6. XLR-3 connectors: pin 1 = ground/common/shield (do not connect to case); pin 2 = +30VDC; and pin 3 = audio/signal.
   a. Production Intercom Headset

7. XLR-4 connectors: pin 1 = microphone shield ("common") (do not connect to case); pin 2 = microphone high ("hot"); pin 3 = earphone low ("common"); pin 4 = earphone high ("hot").
8. Low Volt Loudspeaker Level
    a. Loudspeaker Line
        1) Neutrik NL4 series connectors used for bi-amplified or passive (mono-amplified) sound 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 "-".
        2) 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").
9. Fiber Optic Level
    a. Refer to the manufacturer's specifications.

D. Transducer Polarity
1. Proper polarity of electro-acoustic transducers shall be established as follows, with exceptions as noted:
    a. Microphone: Positive acoustic pressure on the microphone diaphragm produces a positive voltage on pin 2, with respect to pin 3 of the output connector.
    b. Loudspeaker: Positive voltage applied to the (+) terminal produces a displacement of the loudspeaker cone away from the magnet, thus producing a positive acoustic pressure.

3.3 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 at maximum power.
3. All metal cabinets connected to the sound system audio ground network shall be effectively isolated from any conduit or other metallic component that is connected to the building electrical safety ground.

B. Wiring
1. General
    a. 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.
    b. Do not begin pulling Sound, Video & Communication Systems wiring through the SV&C Systems 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.
    c. The Sound, Video & Communication 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.

d. All microphone level, line level, video level, intercom level & DC control, low volt/impedance loudspeaker level, 70.7 volt loudspeaker level, and AC power level wiring shall be restricted to individual and separate conduit systems.
e. All microphone and line level wiring shall be balanced and floating, unless otherwise indicated.
f. Take all necessary precautions to prevent electromagnetic, electrostatic, and radio frequency interference.
g. 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.
h. No splices shall be allowed in Group A, B, D or J (microphone, line, video/RF, Fiber Optic) cables unless it is physically impossible to install the wire in one length; such splices must be approved by the Consultant on a case-by-case basis. When approved, the following splicing methods may be used:
    1) 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.
    2) Female BNC "barrel" connectors for Group D (video) cable. Male BNC connectors shall be provided on cable ends at location of the splice.
    3) No splices shall be allowed for Group J (fiber optic) cables.
i. Splices in Group E (intercom & DC control) cables are permitted only when necessary to effect parallel runs such as may be necessary for "H" intercom runs. Terminal strips or other approved means shall be employed, under review of the Consultant.
j. Splices in Group F (loudspeaker) and Group G (70.7 volt loudspeaker) are permitted without prior approval by the Consultant. Such splices shall be kept to a minimum.
k. 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.

2. Flexible Cords and Cables
    a. 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 Code in Orlando and appropriate regulations as identified in "PART 1 - GENERAL: Safety and Code Requirements".
    b. 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.
    c. 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 multi-core and control circuits.

d. 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.

3. Labeling and Marking
   a. All Sound, Video & Communication Systems wire and cable shall be logically and permanently marked by the Sound, Video & Communication 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.
   b. 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 is recommended. Cloth or vinyl tape-type markers are not acceptable.
   c. The individual pairs of multi-pair cable and individual conductors of multi-conductor cable shall be readily identified by permanent color-coding of the wire insulation. Multi-pair or multi-conductor cable that is identified only by means of the form or order of lay of individual wire is not acceptable.
   d. 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.
4. Termination
   a. All connections and joints shall be made with Tin-Silver-Copper-core solder or an approved mechanical connector.
   b. All multi-pin connectors shall have crimp-type gold-plated contacts.
   c. Where flexible cable joins fixed wiring the terminations shall be accomplished with either a pair of appropriate mating connectors or a suitable terminal block.
   d. 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.
5. Audio Grounding
   a. 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.
   b. Microphone wiring shall have continuous shields from the microphone receptacle to microphone patch jack, and if normalled to a console microphone input, continuous to that point.
   c. Tie-line patch points shall have continuous shield connection from one patch jack to another with no permanent connection to the audio ground network.
   d. 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.
   e. No “doubling up” of ground points on multi-pin connectors or terminal blocks shall be allowed.
   f. Shielded audio cables that normal through patch panels shall utilize a normalling type jack that has an isolated switching “break” circuit. This shall be used for sleeve normalling.
   g. Note: The Consultant recognizes that different contractors use different “in-house” or proprietary patch-panel grounding schemes, and will discuss alternative methods if

such are desired by this Contractor. The grounding scheme employed must be approved by the Consultant.

C. AC Power System
1. Power Distribution
   a. AC power for the Sound, Video & Communication Systems, provided by the Electrical Contractor, is distributed at 120VAC, 60Hz. Refer to the electrical plans for further information.
2. Grounding
   a. The sound 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 Sound, Video & Communication Contractor prior to installation of equipment. Any ground shorts or faults shall be reported for correction by the Electrical Contractor.
   b. 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.
   c. The sound system audio ground network connects all Sound System equipment positions together by a single, low impedance, ground network (specified to be 0.1 ohm). All AC power wall receptacles in Sound, Video & Communication Systems 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.
   d. All Sound 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.
   e. All conduits and back boxes containing Sound, Video & Communication Systems wiring shall be permanently connected to the building electrical safety ground.
   f. Note: Video (RF) and infrared (RF) devices, being unbalanced in nature, shall not be connected to the sound system audio ground network.

D. 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 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 Divisions 26 and 27.

E. 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".

F. Equipment
1. General
   a. Operating parts of all equipment shall be suitably machined and finished. Tolerances, fits, and finishes, etc., where not specified herein or indicated on the drawings, shall conform with best trade practices and the operational intent of the equipment.
   b. 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.
   c. All components and items used in Sound, Video & Communication Systems shall be by a recognized manufacturer specializing in professional Sound, Video & Communication and electrical equipment and shall conform to applicable industry and code standards.
   d. 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.
   e. 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.
   f. All electronic components shall be readily available from at least two recognized manufacturers. Any custom hardware or software shall be supported by readily available spares.
   g. 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.
   h. All integrated circuits containing program code and all circuits with twenty four or more pins shall be mounted in sockets.
   i. 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.

j. Annunciators, indicators, and fuses in individual power and electronic systems shall be standardized and approved by the Consultant before design is finalized.
k. Indicating devices shall be of as few different types as possible and wherever practicable shall have a minimum life of 10,000 hours.
l. 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.
m. Fuses and circuit breakers shall be panel mounted. Fuses shall be mounted in indicating fuse holders, illuminated when the fuse has failed.
n. Where fuses must be concealed they shall be easily accessible.
o. 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.
p. All internal switches shall be clearly and permanently labeled.
q. All connectors external to the equipment shall be of rugged metal construction with self-contained locking devices. Nonmetallic external connector shells are unacceptable.
r. All key-switches 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 key-switch.

2. Assemblies
   a. Manufacturing, assembly, and wiring work shall be carried out by trained and experienced technicians.
   b. 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.
   c. 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. Electrically dissimilar modules or connectors shall not be able to be wrongly connected.
   d. 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.
   e. 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.
   f. 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.
3. Custom Fabrication
   a. 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.

b. 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.
c. 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.

4. Finishes
   a. 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.
   b. Aluminum panel surfaces shall be anodized black or other color as indicated herein or on the drawings.
   c. Finishes subjected to high temperatures shall be of heat-resistant epoxy or other durable high-temperature baked-on enamel finish.
   d. Finishes shall be durable and capable of withstanding normal usage in the areas in which they are installed.
5. Equipment Racks
   a. 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”.
   b. All internal wiring shall be of adequate mechanical strength as well as electrical current rating. Multi-strand 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.
   c. 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.
   d. All terminals, to which connections are to be made by Division 26 shall have clear markings that are unique for each terminal and are as identified on the shop drawings.
   e. 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.
6. Labeling
   a. 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.
   b. Panels and receptacles must be readable in dim lighting. Quality of engraving and filling, letter sizes, etc. shall comply with “Part 2 - Products: General Equipment - Fixed - Receptacle Plates and Combination Panels” of this specification and as approved by the Consultant through shop drawing and sample submittal.
   c. All legends shall be engraved and filled in black on a white background or white on a black background, unless otherwise noted, for maximum contrast against background employed.

d. Where required, engraved, adhesive-backed lamacoid 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.

7. Spare Parts
   a. 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.
   b. 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.
   c. Similar equipment, spares, and replacements shall be electrically and mechanically interchangeable on all equipment forming part of a given system or installation.
   d. The spare parts shall be released to the Owner after completion of the commissioning procedure.

G. 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).

H. Site Work
1. General
   a. The Sound, Video & Communication Contractor shall be responsible for delivery, storage and handling of equipment and tools during the period of the installation.
2. Painting
   a. 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.
   b. 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.
   c. Finish coats on components exposed to view at all locations shall be two (2) coats of approved finish.
   d. The Sound, Video & Communication 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.
   e. All components exposed to view shall be shop painted to match approved samples.
   f. 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.
3. Protection Of Work
   a. Shipping and Storage
      1) The Sound, Video & Communication 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.

2) 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.

3) 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.

4) 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.

5) No equipment shall be shipped to the job site by this Contractor until notification by the Construction Manager that storage facilities are available to protect the equipment prior to installation.

6) The Sound, Video & Communication 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. Refer also to the General Conditions, as amended by the Supplementary Conditions.

b. Installation

1) Installation shall be authorized only when site conditions provide mechanical, electrical, and environmental protection suitable for the electronic equipment.

c. Special Protection of Electronic Equipment and Cable

1) This Contractor shall conform with the following minimum standards and procedures for the storage and protection of the equipment during installation:

a) 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.

b) 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.

c) 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.

3.4 TESTING AND ADJUSTMENT

A. General
1. Perform tests and adjustments to the Sound, Video & Communication Systems as outlined in this specification. These tests and adjustments shall be completed at the time(s) specifically indicated in "PART 1 - GENERAL: Commissioning."

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 line voltage power to Sound, Video & Communication Systems 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 Sound, Video & Communication Systems has been correctly installed and is fully operational.

C. Conditions
1. Do not use any major control equipment intended for installation in the Sound, Video & Communication Systems 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 Sound, Video & Communication Systems equipment.
2. Electro-acoustic 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 Sound, Video & Communication 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 adapters, cables, and connectors necessary to interconnect the test equipment devices to each other and to the Sound, Video & Communication Systems equipment.
    a. Sweep/Function Generator
    b. Frequency Counter
    c. Pink Noise Generator
    d. Digital-Storage Dual-Trace Oscilloscope
    e. Digital Multi-meter
    f. Polarity Testing System
    g. Impedance Meter
    h. Audio Component Test Set
    i. Sound Level Meter meeting IEC 60651 Type 1 specifications with octave band measurement capabilities
    j. Real-Time One-Third Octave Audio Spectrum Analyzer
    k. Meyer Sound SIM3 Measurement System and Operator
    l. Two-Way Radios

E. Procedure
1. Perform the following tests and adjustments to the Sound and Communication Systems. 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. General Testing
    a. Continuity
        1) Test all permanent Sound and Communication Systems wire and cable 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 multi-pair or multi-conductor cable and between each conductor and the conduit (building safety ground). Use a continuity meter for all tests. Bell and buzzer testing “rigs” are not acceptable.
        2) Test all Sound and Communication Systems components to and from the patch panel 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. This shall include, but not necessarily be limited to, devices connected to receptacle plates, combination panels, and patch panels.
    b. Polarity
        1) Measure and verify electrical and electro-acoustic polarity of all Sound and Communication System components to ensure that the entire system is properly connected (i.e., the system shall be “in phase”). This shall include, but not necessarily be limited to: microphones (and other transducers), loudspeakers, infrared receiver/headsets, all electronic components, all permanent wiring, patching, and receptacle panels, and portable cables. Ensure that absolute polarity is maintained throughout all signal paths, regardless of patching or other routing changes. Refer to polarity details in the “Definitions” section above.
        2) Document all wiring or termination changes made in order to maintain system polarity.
    c. Impedance

1) Measure and document the impedance of each microphone and line level line at the patch-panel, terminated at the opposite end 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.
2) Measure and document the impedance of each low-voltage 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.
3) Measure and document the impedance of each low-voltage (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.
4) Test each full-range loudspeaker line at 63Hz, 250Hz, 1kHz, 4kHz, 8kHz, and 16kHz.
5) 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.
6) 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.

d. Radio Frequency Interference
1) Use a minimum 60 MHz bandwidth oscilloscope in conjunction with loudspeaker or infrared receiver/headset monitoring to ensure that the sound and/or communication system under test is free of spurious oscillation and radio frequency interference (RFI). Measure and document all results.

e. Gain Structure
1) Set and document input and output gain controls on all Sound and Communication Systems 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.
2) 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.
3) Conduct listening tests from center of coverage of each high-frequency horn device to determine that there is no audible hiss.
4) Final gain adjustment of equalizers and other processing equipment shall be made only after the completion of the equalization process.

f. Electronic Signal Path
1) 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 Sound and Communication Systems. Measured values must be as published by the manufacturer, or better.
2) 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 band-pass for a particular circuit. (Refer to manufacturers' published data).

3) 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.

4) Measure and document maximum output before clipping (headroom) and total harmonic distortion of each active device with methods recommended by the equipment manufacturer.

5) 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. See note above under Gain Structure and concerning audible hiss.

g. Power Output

1) 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.

h. Buzzes, Rattles, Distortion

1) 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 Sound and Communication Systems 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 S&C Systems equipment and/or the scope of this section of the contract, promptly notify the Owner and Consultant of the cause and suggested corrective procedure.

i. UTP and Fiber Optic Cable Testing

1) Refer to ISO/IEC 11801: Information technology Generic cabling for customer premises.

3. Installed Loudspeaker System Measurement and Optimization

a. General

1) The following tests shall be conducted as part of the SIM3 measurement and optimization process. The goals of this process are as follows: 1) to achieve minimum level, spectral, and ripple variance over the listening area; 2) to achieve maximum coherence; 3) to achieve maximum power capability; and 4) to achieve sonic image control.

2) The SIM3 measurement and optimization process shall be performed for a minimum of two (2) adjustable room acoustics configurations to be specified by the Consultant.

b. Optimization of Loudspeaker Position, Focus Angle, and Splay Angle
   1) Measure and document performance of loudspeakers in specified positions and locations to determine optimal position and location of loudspeakers either singly or with a group. Adjust position and location as necessary.

c. Sound Pressure Level
   1) Measure and document sound pressure level of loudspeaker arrays throughout the seating areas and adjust loudspeaker levels, as necessary, to achieve coverage of +/- 3dB, or better, with a peak continuous level of 105dB SPL. Take all readings at seated ear level height.

d. Loudspeaker Time Alignment
   1) Measure and document the time alignment of the loudspeakers either singly or within an array. Adjust digital signal processing units as necessary to achieve the best average signal alignment between components.

e. Frequency Response
   1) Measure and document the frequency response of each loudspeaker array, as measured in both the reverberant field and near field, to ensure that the frequency response is within +/-3dB from 20Hz to 20kHz. Adjust equalization as necessary.

f. Speech Intelligibility
   1) Perform subjective and/or objective speech intelligibility measurements or surveys throughout the facility and make adjustments as necessary to the Sound and Communication Systems for maximum speech intelligibility. Submit proposed methods of testing to the Consultant for approval.

g. Ambient Noise Level
   1) Measure and document the ambient noise level at a distance of one meter from each loudspeaker or array over eight ISO octave bands. Plot data on a PNC curve chart and verify that the specified PNC rating has been met.
   2) Conduct listening tests from center of coverage of each high-frequency horn device to determine that there is no audible hiss.

4. Assistive Listening System Testing
   a. General
      1) Assistive Listening System testing, measurements, and adjustment shall be performed as directed by the Consultant. System coverage shall include all audience seating locations.

   b. Audio Inputs
      1) The Assistive Listening System provides for different audio level inputs, as shown on the block diagram and outlined below, to function properly as the sole audio transmission medium to users of the system in each of the audience chambers.
      2) The program monitor system microphones shall be the default program source for the Assistive Listening System, feeding “direct sound” from the platform to the Assistive Listening System integrated signal processor via the program monitor mixing and distribution system.

   c. Frequency Response
      1) Adjust equalizer for maximum roll-off below 125Hz, if possible (depending on the extent of equalization required above).

2) Using a wide range of "typical" music and dramatic program material as the input source, fine-tune the frequency response if further adjustment is required to properly equalize the system.

d. Dynamic Range
   1) Set the compressor controls to reduce the overall dynamic range by at least half. The recommended initial compressor threshold setting is 20dB below the nominal system operating level, and recommended initial compressor ratio setting is 3:1.
   2) Using a wide range of "typical" music and dramatic program material as the input source, fine-tune the compressor settings if further adjustment is required to achieve an acceptably narrow dynamic range.

e. User Verification of System Performance
   1) Use prerecorded music from a compact disc player (or other approved device) as a test source, and slowly "walk" through all seating sections at all levels of the audience chamber, while carefully listening to the broadcast Assistive Listening System signal. Ensure that signal reception of acceptable quality reaches all seats in the audience chamber. Ensure that signal delay is adjusted appropriately for mid-orchestra section seats.

5. Communication System Testing
   a. General
      1) Electro-acoustic testing, measurements, and equalization shall be performed in the following two (2) different acoustic setup conditions, as outlined below, and as directed by the Consultant:
      2) All acoustic control curtains completely retracted (all hard wall surfaces exposed).
      3) All acoustic control curtains completely extended (most hard wall surfaces covered by dark fabric).
      4) Measure and document electro-acoustic testing, as described above, within two (2) different types of environments:
      5) Under unoccupied (quiet) conditions.
      6) Under "production" conditions (i.e. noise levels equal to or exceeding a normal performance or production situation). Use a suitable source such as program material, live performance, or other as approved.
      7) Component Testing: Test all communication control panels at all assigned locations throughout the facility. Test for proper signal flow, switching control, LED operation, and paging operation. Test all volume controls and integral priority paging defeat circuits and switches to ensure that the amplified sound is free from any distortion throughout all attenuation steps and relay/switch settings.
   b. Production Intercom
      1) Follow manufacturer's installation manual.
   c. Program Monitor/Paging System Loudspeakers
      1) Frequency Response
         a) Measure and document the frequency response of all ceiling mounted program monitor / paging loudspeakers. Results shall be flat from 100Hz to 3kHz, and shall roll off at a rate of 3dB per octave, from 3kHz to 10kHz, +3dB.
         b) Measure and document the frequency response of all control room monitor loudspeakers. Results shall be flat from 120Hz to 3kHz, and shall roll off at a rate of 3dB per octave, from 3kHz to 10kHz, +3dB.
      2) Sound Pressure Level

a) Measure and document sound pressure level of the all program monitor/paging loudspeakers to achieve even coverage of +4dB, or better, with a maximum continuous level of 85dB SPL, (band limited from 500Hz to 3kHz).
b) Measure and document sound pressure level of each control room monitor loudspeaker throughout the control room to achieve even coverage of +4dB, or better, with a maximum continuous level of 90dB SPL.

d. Production Video (CCTV) System
1) CCTV (Baseband) Cameras: Measure, verify, and document proper operation of all cameras as follows:
a) Using appropriate test charts and TV waveform monitor, measure peak white level, sync level, and sync width:
b) Peak white level: 100 IRE (714mV)
c) Sync level: 40 IRE (286mV)
d) Sync width: 4.5ms to 4.8ms
e) Use a video monitor to check for missing pixels by covering the camera lens with a black card. Missing pixels will charge white on a video monitor when light is blocked and AGC circuits are at maximum gain. The number of missing pixels shall not exceed the manufacturer's specifications.
2) 75-ohm Precision (CCTV) Cable: Measure and document the level of hum in 75-ohm cable as follows:
a) Connect a video test signal of 100 IRE peak luminance to one end of each cable.
b) Measure level of hum at other end of cable with a TV waveform monitor (set for scanning at frame rate).
c) Hum should be no more than 5% of the signal level of 100 IRE.
d) Measure and document the line loss in 75-ohm cable as follows:
e) Use a TV test signal generator window signal that goes up to peak white at one end of each cable.
f) At the other end of each cable, measure the signal with a waveform monitor.
g) Signal should not exceed a line loss of more than 10 IRE.
h) With the same signal, if burst is less than 35 IRE, then cable equalization is required.
3) Distribution Amplifier Performance
a) Check Frequency Response:
b) With a video test signal of 100 IRE peak luminance at the input of each device.
c) - With a waveform monitor at the output of each device, the signal should not exceed 4% loss at 4.2MHz.
d) Check and Adjust Gain:
e) Use a video test signal of 1V p-p, 75% color bars at the input of each device.
f) With a waveform monitor at the output of each device, adjust for unity gain $^{+}$0.5dB.
g) Check Noise Level:
h) With no signal at the input of each device, measure noise levels at the output(s) on a waveform monitor.

i) Noise voltage levels shall not exceed -55dB, that is 2.0mV p-p ref. 1.0V p-p.

4) Video Monitors
   a) Adjust Contrast:
   b) Use SMPTE color bars video test signal at the input of each color monitor.
   c) Adjust the contrast so no visible blooming in the monitor is present and the luminance stairstep is balanced and uncompressed.
   d) Adjust Brightness:
   e) Use SMPTE color bars video test signal at the input of each color monitor.
   f) Adjust the brightness so that the 7.5 position on the pluge signal is barely visible.
   g) Check Purity:
   h) Each color video monitor should be free from purity problems as viewed with a full white field.

5) Overall System Performance: Through the use of TV test signals and a TV waveform monitor, insure that the overall CCTV system meets these specifications:
   a) Frequency response: $^{+}$0.5dB, 60 to 4.2MHz
   b) Insertion amplitude: 1V p-p (100 IRE)
   c) Signal levels: 1V p-p $^{+}$3 IRE
   d) Chrominance-to-luminance gain inequality: $^{+}$5 IRE
   e) Signal-to-noise ratio: 56dB
   f) Hum: 5% hum to peak modulation
   g) Noise: within 5% of manufacturer's specification

e. IPTV Video System
   1) Refer to ISO/IEC 13818-4: Generic coding of moving pictures and associated audio information -- Part 4: Conformance testing.

END OF SECTION

SECTION 28 0721
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: 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, 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.

D. Network fire alarm control units shall include all features as described in this specification for stand-alone FACUs and shall have network communication capabilities as described herein.

1. All points monitored and controlled by a single node shall be capable of being programmed as "Public". Each point made public to the network may be programmed to be operated by any other node connected to the network.
2. Network communications shall be capable of supporting "point lists" that can be handled as though they were a single point.
3. The network shall provide a means to log into any node on the system via a laptop computer and have complete network access (Set Host) for diagnostics, maintenance reporting, and information gathering of all nodes in the system. Systems not meeting this requirement must provide all diagnostic tools required to support this function from selected points on the network. This Section covers fire alarm systems, including initiating devices, notification appliances, controls, and supervisory devices.

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. Remote panel site-specific software and executive firmware downloads shall be capable of being performed over proprietary fire alarm network communications.
5. 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.
6. 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.

7. 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 have the capability 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, or
   b. Bi-weekly, or
   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 have the capability 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 fire pump power failure, 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 gas detection, chemical leak detection, intrusion alert,, 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-alarming 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. Integrated Automation
1. Security Integration
    a. The FA System shall provide the means to be integrated directly to a Software House

C•Cure 9000 or 800 Security Management System (SMS) via a software interface for the purpose of communicating fire alarm events directly to the security system.

b. Communication between the FA System and SMS shall be accomplished using Computer Port Protocol (CPP).
   (1) The FA and the C•Cure SMS shall be connected via a local or network serial port server based RS-232 serial port connection.

c. The CPP shall consist of a bi-directional serial protocol capable of accessing most of the Fire Alarm Control Unit (FACU) diagnostic features.

d. The interface shall provide the means to communicate the following information to the C•Cure SMS:
   (1) Device/Point status changes (e.g., Fire, Trouble, Disabled)
   (2) Panel event status (e.g. Number of Unacknowledged Fire Alarms, Card Failure Troubles, etc.)
   (3) Panel health status (e.g., AC power, battery status)

e. Interface software shall include a data acquisition function that provides the following:
   (1) Establishes and maintains a supervised serial link
   (2) Extraction of the point database from the FACU
   (3) Merges the FACU database into the C•Cure SMS database

f. The software interface shall not allow system control functionality from the C•Cure SMS to the FA System.

g. The installation, programming and maintenance of the FA/C•Cure integration software interface shall be conducted by factory trained certified technicians.

2. Building Automation and Control Network (BACnet) Integration
   a. The fire alarm control unit shall be capable of providing a one-way communications interface between the fire alarm control unit and an industry-standard Building Automation and Control Network (BACnet) using ASHRAE® BACnet® IP (internet protocol) compliant with ANSI/ASHRAE Standard 135.
   b. The BACnet communications module shall be agency listed to UL Standard 864.
   c. The fire alarm control unit shall be capable of communicating up to 1000 status changes to the building automation system.
   d. MS/TP Master and MS/TP Slave data link layer options communicating at baud rates up to 76,800 bps shall be supported.
   e. The interface shall be capable of supporting ANSI X3.4, ISO 10656 (ICS-4), ISO 10656 (UCS-2), ISO 8859-1, or IBM/Microsoft DBCS character sets.
   f. A standard RJ-45 Ethernet connection to the Building Automation System Ethernet network shall be provided at the fire alarm control unit as part of the contract.
3. Refer to section: 25.00 Integrated Automation

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 horns in areas as indicated on drawings.

M. 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.

N. 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.

O. 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.

P. 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.

Q. Firefighter's Phone: Provide a supervised, two-way communication system between the Command Center/main fire alarm control unit and emergency phones.

1. The firefighter's phone system shall be capable of handling single or simultaneous conversations with all phones connected into the system. As many as six phones shall be able to be connected into the active conversation.

2. The phone system circuits shall be designed to prevent static, hum or other interference for clear, intelligible two-way conversation between all phones of the system.

3. The phone system circuits shall be supervised, such that the FACU shall be able to differentiate between whether a handset has been plugged into the emergency phone jack and whether the circuit has a shorted wire.

4. A beeping busy signal shall indicate to the person attempting to use a remote phone that the signal is being received at the control unit and that the lines are intact.

5. The act of plugging a handset into an emergency phone jack or removal of any phone from its normal hook position shall cause an audible and visual indication at the control unit. Picking up of the master phone and acknowledgment of the phone circuit shall silence the tone and allow for direct two-way communications.
6. The act of unplugging handsets in use and replacement of remote phones to their cradle shall restore normal supervisory functions.
7. Provide emergency phone jacks for installation in each elevator car by the elevator contractor. Required wiring from elevator controls to each elevator car shall be furnished and installed by the elevator contractor.
8. Provide emergency phone jacks as shown on the plans. Each jack shall be mounted on a stainless steel single gang plate with the words "Fire Emergency Phone" screened on each.
9. Provide a minimum of five (5) pluggable emergency phones within a storage cabinet.

R. Network Communication:

1. Network node communication shall be through a token ring, hub, or star topology configuration, or combination thereof.
2. A single open, ground or short on the network communication loop shall not degrade network communications. Token shall be passed in opposite direction to maintain communications throughout all network nodes. At the same time the status of the communication link shall be reported.
3. If a group of nodes becomes isolated from the rest of the network due to multiple fault conditions, that group shall automatically form a sub-network with all common interaction of monitoring and control remaining intact. The network shall be notified with the exact details of the lost communications.
4. Fiber optics communication shall be provided as an option via a fiber optics modem. Modem shall multiplex audio signals and digital communication via full duplex transmission over a single fiber optic cable, either single mode or multi mode.
5. The communication method shall be NFPA 72 style 7.

S. Network Synchronization of Notification Appliances

1. The fire alarm and emergency communications network shall be capable of providing UL Listed synchronization across all the notification appliance circuits for all panels on a network loop in accordance with the requirements of UL 1971.
2. Systems that require all notification appliances to be connected to a single panel for synchronization thus creating a potential single point of failure shall not be acceptable.
3. Up to 99 panels on a network loop shall be capable of UL Listed synchronization of all notification appliance circuits across the network loop in accordance with the requirements of UL 1971.
4. Should network communications be disrupted, re-synchronization shall occur across all nodes that continue to communicate together after network re-initialization is completed and restored to affected nodes.

T. Addressable Notification Appliances (Applies only where addressable notification is provided):

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:
            i. General Evac
            ii. Alert
            iii. User Defined
         (b) Style:
            i. Indoor
            ii. UL Weatherproof
            iii. ULC Weatherproof
         (c) Candela Selections:
            i. Indoor: 15, 30, 75, 110, 135, or 185 cd (per UL1971)
            ii. UL Weatherproof: 15 or 75 cd (per UL1971), and 75 or 185 cd (per UL1638)
            iii. ULC Weatherproof: 20, 30 or 75 cd (per ULCS526)
         (d) Horn Volume:
            i. Hi
            ii. Low
         (e) Horn Cadence:
            i. Temporal 3
            ii. Temporal 4
            iii. March Time 20 bpm
            iv. March Time 60 bpm
            v. March Time 120 bpm
            vi. Steady
         (f) Horn Tone:
            i. 520 HZ
            ii. Bell
            iii. Slow Whoop

iv. Siren

v. 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.

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.

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:

(a) Point ID

(b) Custom Label

(c) Device Type

(d) Candela Setting

(2) At minimum, the self-test report shall include the following information applicable

for each self-test notification appliance:

(a) Point ID

(b) Custom Label

(c) Time and Date of last test

(d) Pass / Fail results of last visual test

(e) 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 PROJECT CONDITIONS

A. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:

1. Notify Architect no fewer than two days in advance of proposed interruption of fire-alarm service.

2. Do not proceed with interruption of fire-alarm service without Architect's written permission.

1.9 SEQUENCING AND SCHEDULING

A. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service and label existing fire-alarm equipment "NOT IN SERVICE" until removed from the building.

B. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

1.10 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.

1.11 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.

1.12 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.

B. 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.

C. Printer Ribbons: Furnish 6 spare printer ribbons when a printer is provided.

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 must be submitted to the Engineer two weeks prior to bid for approval. 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.

D. The equipment and service provider shall be a nationally recognized company specializing in fire alarm and detection systems. This provider shall employ factory trained and NICET Level IV certified technicians, and shall maintain a service organization within 50 miles of this project location. The equipment and service provider shall have a minimum of 10 years experience in the fire protective signaling systems industry.

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. Flame detectors.
4. Smoke detectors.
5. Duct smoke detectors.
6. Verified automatic alarm operation of smoke detectors.
7. Automatic sprinkler system water flow.
8. Heat detectors in elevator shaft and pit.
9. Fire-extinguishing system operation.
10. 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. Activate smoke-control system (smoke management) at firefighter smoke-control system panel.
   9. Activate stairwell and elevator-shaft pressurization systems.
   10. Close smoke dampers in air ducts of designated air-conditioning duct systems.
   11. Recall elevators to primary or alternate recall floors.
   12. Activate emergency lighting control.
   13. Activate emergency shutoffs for gas and fuel supplies.
   14. Record events in the system memory.
   15. 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.
   3. Elevator shunt-trip supervision.

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.
   9. Fire-pump power failure, including a dead-phase or phase-reversal condition.

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. Power Supplies with integral conventional reverse polarity Notification Appliance Circuit Class B for system expansion. Expansion power supplies shall provide complete capability as the primary power supply.
12. 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.

13. 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.
14. Remote Unit Interface: supervised serial communication channel for control and monitoring of remotely located annunciators and I/O panels.
15. Programmable DACT for per Point Reporting.
16. 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.
17. Modular Network Communications Card.

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.

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.

1. The system shall have the capability to provide expanded content, multi-line, operator interface displays. The expanded content multi-line displays shall be Quarter-VGA (QVGA) or larger and be capable of supporting a minimum of 854 standard ASCII characters to minimize or eliminate the levels of navigation required for access to information when responding to critical emergencies and abnormal system conditions. The QVGA operator interface shall provide operator prompts and six context sensitive soft-keys for intuitive operation.
   a. Expanded content, multi-line operator interfaces shall be capable of providing the following functions:
      (1) Dual language operation with Instant-Switch language selection during runtime.
      (2) Activity display choices for:
         (a) First 8 Events.
         (b) First 5 Events and Most Recent Event (with first and most recent event time and date stamps).
         (c) First Event and Most Recent Event (with first and most recent event time and date stamps).
         (d) Scrollable List Display
         (e) General Event Status (alarm, priority 2, supervisory, or trouble in system)
         (f) Site Plan
      (3) Equal or hierarchal priority assignment. In systems with two or more operator interfaces, each operator interface shall be programmable to allow multiple operator interfaces to have equal operation priority or to allow hierarchal priority control to be assigned to individual operator interfaces (locations).
      (4) Up to 50 custom point detail messages for providing additional point specific information in detailed point status screens.
      (5) Bitmap file import for operator interface display of site plan and background watermark images.
   b. Expanded content, multi-line displays shall have the capability to provide Dual-Language

operation.

(1) Language selection shall be via a switch on the operator interface panel. Operator interface panels shall support instant-language-switchover during runtime to allow the operator to toggle between languages each time the language selection switch is operated, without requiring complicated multi-step processes.

(2) Both one-byte and two-byte characters shall be supported.

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.
6. When required, Redundant Voice Command Centers shall be capable of generating voice paging from more than one node in a network audio system.

G. Evacuation System - Non-Alarm Audio

1. The fire alarm control unit shall provide non-alarm audio from an owner supplied paging and/or music source over the fire alarm evacuation speakers. This feature shall be an integral

part of the fire alarm system, and shall use some or all of the audio components from the fire alarm evacuation system.

2. The fire alarm system and the non-alarm audio operation shall comply with NFPA 72 requirements for non-emergency purposes at a fire command center that is not constantly attended by a trained operator.
3. All fire alarm system hardware and software shall be U.L. listed for non-alarm audio use. The fire alarm system shall supervise for system hardware and field wiring faults while playing non-alarm audio over the evacuation speakers. Any hardware failure or speaker circuit fault detected when the system is playing non-alarm audio shall report a trouble on the fire alarm control unit. All audio components used for both the non-alarm audio and the fire alarm evacuation system shall be manufactured by the same supplier.
4. The non-alarm audio shall have two dedicated audio inputs to the fire alarm control unit. Terminal strip connections and an industry standard RCA receptacle shall be provided at the fire alarm control unit for terminating the owner's audio source. The fire alarm input shall be 600-Ohm impedance. The inputs on the fire alarm control unit shall be electrically isolated via an isolation transformer.
5. The fire alarm control unit shall accept industry standard "line level audio input" from the owner's non-alarm audio source. The fire alarm system hardware and software shall distribute the audio over the fire alarm evacuation speakers. The selection of which speaker zones to distribute the non-alarm audio to the building occupants shall be coordinated with the owner's representative.
6. The fire alarm control unit shall be able to make audio input level adjustments from the owner's non-alarm audio source. This adjustment will match the non-alarm audio source to the fire alarm input. After the audio levels are adjusted, the owner shall control the volume level from the non-alarm audio source.
7. The fire alarm system will have the capability to provide operator "keys" that will adjust the volume level of pre-assigned non-alarm audio zones. The volume level of non-alarm audio that is being broadcast to any audio zone will also be individually adjustable by time of day via a pre-specified schedule.
8. The non-alarm audio shall be the lowest priory audio on the fire alarm system. The non-alarm audio shall not interfere with any of the fire alarm emergency signals that may include live voice, pre-recorded emergency voice messages, or any alert tones. Switches shall be located on the fire alarm control unit to turn on or off the non-alarm audio system feature. The fire alarm control unit shall have LED lamps to indicate the ON vs. OFF status of the non-alarm audio feature. Speaker circuits that are actively broadcasting non-alarm audio will also be indicated by LEDs.
9. The non-alarm audio shall be synchronized throughout the fire alarm life safety system amplifiers and speaker circuits. Any remote amplifier panels located on the fire alarm system network shall also be synchronized. The system shall be capable of accepting a system-wide non-alarm audio input at the main fire alarm control or another local non-alarm audio input at a remote amplifier panel to serve only the areas served by that remote panel.
10. Multiple non-alarm audio sources must be accessible by the fire alarm non-alarm audio system. Each separate non-alarm audio source will have the ability to be broadcast into a distinct fire zone, depending on occupant preference. Any system restricted to a limited number of non-audio sources will not be accepted. The system must have the capability of broadcasting an unlimited number of non-alarm sources, except as determined by the number of individual fire zones served by the fire alarm system.
11. Non-alarm audio shall be automatically turned off in the event of primary power failure to the

fire alarm control unit or any of the remote amplifier panels controlled by the main fire alarm control unit.

H. Fire fighters' telephone communication system: Arrange system to use dedicated, two-way, supervised voice communication links between the FACU and remote fire fighters' telephone stations throughout the building.

2.4 NON-SYSTEM SMOKE DETECTORS

A. Single-Station Smoke Detectors:

1. Comply with UL 217; suitable for NFPA 101, residential occupancies; operating at 120-V ac with 9-V dc battery as the secondary power source. Provide with "low" or "missing" battery chirping-sound device.
2. Auxiliary Relays: One Form C rated at 0.5 A.
3. Audible Notification Appliance: Piezoelectric sounder rated at 90 dBA at 10 feet (3 m) according to UL 464.
4. Visible Notification Appliance: 177-cd strobe as required per floor plans.
5. Heat sensor, 135 deg F (57 deg C) combination rate-of-rise and fixed temperature.
6. Test Switch: Push to test; simulates smoke at rated obscuration.
7. Tandem Connection: Allow tandem connection of number of indicated detectors; alarm on one detector shall actuate notification on all connected detectors.
8. Quick-disconnect wiring harness.
9. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
10. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status.

B. Single-Station Duct Smoke Detectors:

1. Comply with UL 268A; operating at 120-V ac.
2. Sensor: LED or infrared light source with matching silicon-cell receiver.
   a. Detector Sensitivity: Smoke obscuration between 2.5 and 3.5 percent/foot (0.008 and 0.011 percent/mm) when tested according to UL 268A.
3. Detector shall be twist-lock mounted to a fixed base inside a duct mounted housing with associated electronic components. Provide terminals in the duct housing for connection to building wiring.
   a. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.
4. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
5. Fan Shutdown Relay: Rated to interrupt fan motor-control circuit.
6. Provide a red alarm LED, a green power-on LED, a piezoelectric tone-alert silence switch, and a key switch for selecting normal operating mode or to initiate a test or reset operation all mounted to a stainless steel 2-gang electrical plate to be provided in a constantly attended location or located as per the AHJ.
7. Provide test port on duct housing for functional smoke testing access with cover in place.

C. ADDRESSABLE INITIATING

D. 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 double- 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.
5. California Building Code, Title 24: Where required pull station shall be operable with one hand and shall not require tight grasping, pinching or twisting of the wrist. Provides a more easily operated pull station lever compared to standard stations.
6. Weatherproof Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.

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.
2. Addressable CO Sensor Sounder Base
   a. The CO Sensing element shall support operation with a Sounder base; the CO Sensor

Sounder base shall provide temporal code 3 (TC3) for fire, or temporal code 4 (TC4) for toxic carbon monoxide alarms.

b. The CO Sensor Sounder base shall be listed to UL464, Audible Signal Appliances.

c. CO sensor shall provide enhanced fire detection with the addition of two selectable modes of operation: Nuisance Alarm Reduction Mode and Faster Fire Detection.

d. The CO Sensor Sounder Base shall include CO sensor element mounted in the sounder base which can be easily replaced without replacing the complete sensor base assembly.

e. The CO Sensor Sounder 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.

f. The CO Sensor Sounder Sensor base shall include an integral red LED to indicate the power-on, trouble, test mode or alarm status.

g. The CO Sensor Sounder 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.

h. The CO Sensor Sounder Base shall be interchangeable with the CO Sensor 520 Hz Sounder Base.

3. Addressable CO Sensor 520 Hz Sounder Base

a. The CO Sensing element shall support operation with a 520 Hz Sounder base; the 520 Hz CO Sounder base shall provide temporal code 3 (TC3) for fire, or temporal code 4 (TC4) for toxic carbon monoxide alarms.

b. Emitted tone shall be a 520Hz Square Wave signal in compliance with the requirements of the 2010 edition of NFPA 72 for sleeping areas.

c. The CO Sensor 520Hz Sounder base shall be listed to UL 268 and UL464, Audible Signal Appliances.

d. CO sensor shall provide enhanced fire detection with the addition of two selectable modes of operation: Nuisance Alarm Reduction Mode and Faster Fire Detection.

e. The CO Sensor 520 Hz Sounder Base shall include CO sensor element mounted in the sounder base which can be easily replaced without replacing the complete sensor base assembly.

f. The CO Sensor 520 Hz Sounder 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.

g. The CO Sensor 520 Hz Sounder base shall include an integral red LED to indicate the power-on, trouble, test mode or alarm status.

h. The CO Sensor 520 Hz Sounder 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.

i. The CO Sensor 520 Hz Sounder Base shall be interchangeable with the standard CO Sensor Sounder Base.

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 CONVENTIONAL INITIATING

A. CONVENTIONAL 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: Conventional double- 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 terminal strip to accommodate wiring connections to fire-alarm control unit Initiating Device Circuit. Where double-action stations are provided, the mechanism shall require two actions push top activation door to initiate an alarm.
3. 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.
4. California Building Code, Title 24: Where required pull station shall be operable with one hand and shall not require tight grasping, pinching or twisting of the wrist. Provides a more easily operated pull station lever compared to standard stations.
5. Weatherproof Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.

2.6 ADDRESSABLE NOTIFICATION

2.7 CONVENTIONAL NOTIFICATION

2.8 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.

2.9 MAGNETIC DOOR HOLDERS

A. Description: Units shall be listed to UL 228. Units are equipped for wall or floor mounting as

indicated and are complete with matching door plate. Unit shall operate from a 120VAC, a 24VAC or a 24VDC source, and develop a minimum of 25 lbs. holding force.

B. Material and Finish: Match door hardware.

2.10 REMOTE PC ANNUNCIATOR, PC ANNUNCIATOR CLIENTS AND PRINTERs

A. Fire Alarm Control Unit shall be capable of operating remote PC Annunciators and/or printers; output shall be ASCII from an RS-232-C connection with an adjustable baud rate.

B. Fire Alarm Control Unit shall be capable of operating an Agency Listed PC Annunciator Client/Server which provides status annunciation and limited system control using a convenient and familiar Microsoft Windows 7 Professional operating system-based interface. Other compatible Operating Systems shall include Microsoft Vista Business, XP Professional and Windows® 2000 Professional. The PC Annunciator Client/Server shall provide the following functions:

1. Login/logout password protection with time duration selectable automatic logout.
2. Display Alarm, Supervisory, Priority 2, and Trouble conditions with numerical tallies for each.
3. Display first and last alarms.
4. Different event types have separate visible indicators with a common audible indicator.
5. Event logs can be searched and printed.
6. View and/or print TrueAlarm status reports and service reports. (printing requires an available local or network printer).
7. Alarm Silence; System Reset; and Priority 2 Reset.
8. Global and individual point acknowledge.
9. Set system time and date and clear event log.
10. Individual point access for control or parameter revisions.
11. WALKTEST system test is supported for service convenience.
12. Up to (8) Simultaneous Client connections shall be supported by the PC Annunciator Server. Remote Clients shall be capable of connecting to the PC Annunciator Server via Ethernet LAN/WAN connections.

C. Each RS-232-C port shall be capable of supporting and supervising a remote Printer or PC Annunciator; the FACU shall support as many as five (5) remote RS-232 devices in any combination.

2.11 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.

2.12 REMOTE QVGA LCD ANNUNCIATOR

A. Provide a remote QVGA LCD Annunciator, where required, with the same "look and feel" as the FACU operator interface. The Remote QVGA LCD Annunciator shall use the same Primary Acknowledge, Silence, and Reset Keys as the FACU.

B. The QVGA Annunciator shall have an expanded content, multi-line display capable of supporting a minimum of 854 standard ASCII characters to minimize or eliminate the levels of navigation required for access to information when responding to critical emergencies and abnormal system conditions. The QVGA Annunciator shall provide:

1. Operator prompts and six context sensitive soft-keys for intuitive operation.
2. Seven (7) programmable control switches and associated LEDs.
3. Three (3) programmable general purpose LEDs.
4. Capability of supporting Dual Languages with Instant-Switchover between languages in runtime operation.
5. Support for both one-byte and two-byte characters.

C. Under normal conditions the QVGA LCD shall display a "SYSTEM IS NORMAL" message, the current time and date, and the quantity of abnormal status conditions for each event category (i.e., fire alarm, priority 2, supervisory, and trouble).

D. The QVGA Annunciator shall be programmable for the following Activity display choices:

1. First 8 Events.
2. First 5 Events and Most Recent Event with First and Most Recent event time and date stamps.
3. First Event and Most Recent Event with First and Most Recent event time and date stamps.
4. Scrollable List Display displays a scrollable list of active points for the event category (alarm, priority 2, supervisory, or trouble) selected. The position in this list will be the last acknowledged point (not flashing) at the top followed by the next 7 unacknowledged points (flashing).
5. General Event Status (Alarm, Priority 2, Supervisory, or Trouble in system).
6. Site Plan with optional status icons to indicate area status for highest priority active events.

E. Should an abnormal condition be detected the appropriate LED (Alarm, Priority 2, Supervisory or Trouble) shall flash. The unit audible signal shall pulse for alarm conditions and sound steady for trouble and supervisory conditions.

F. The QVGA LCD shall display the following minimum 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).

G. QVGA Annunciators shall be protected from unauthorized use via a locked door or equivalent

means. In addition, in systems with two or more Annunciators, each Annunciator shall be programmable to allow multiple Annunciators to have equal operation priority or to allow hierarchal priority control to be assigned to individual Annunciators (locations). Acknowledge, Silence and Reset operation shall be the same as the FACU.

2.13 GRAPHIC ANNUNCIATOR - LED TYPE

A. Annunciator Unit, zoned system: Provide an LED-indicating light located on the floor plan for each zone. Mark zone boundaries on the annunciator floor plan.

B. Annunciator Unit, addressable system: Provide an LED-indicating light located on the floor plan for each device indicating the type of device and floor on which a signal was actuated.

C. Provide individual LED indicators for each alarm and supervisory device or zone and a LED to indicate system trouble. Additional LEDs indicate normal power and emergency power modes for the system. A toggle or push-button switch tests the LEDs mounted on the unit. The test switch does not require key operation.

D. Enclosure: Finish to match Fire Alarm Control Units. The locking cover/display assembly is hinged on the left. Key and lock shall be common to all secured fire alarm system enclosures.

2.14 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.

2.15 RADIO ALARM TRANSMITTER

A. Transmitter shall comply with NFPA 1221 and shall be listed and labeled by an NRTL.

B. Comply with 47 CFR 90.

C. Description: Manufacturer's standard commercial product; factory assembled, wired, tested, and ready for installation and operation.

1. Packaging: A single, modular, NEMA 250, Type 1 metal enclosure with a tamper-resistant flush tumbler lock.
2. Signal Transmission Mode and Frequency: VHF or UHF 2-W power output, coordinated with operating characteristics of the established remote alarm receiving station designated by Owner.
3. Normal Power Input: 120-V ac.
4. Secondary Power: Integral-sealed, rechargeable, 12-V battery and charger. Comply with NFPA 72 requirements for battery capacity; submit calculations.
5. Antenna: Omnidirectional, coaxial half-wave, dipole type with driving point impedance matched to transmitter and antenna cable output impedance. Wind-load strength of antenna and mounting hardware and supports shall withstand 100 mph (160 km/h) with a gust factor of 1.3 without failure.
6. Antenna Cable: Coaxial cable with impedance matched to the transmitter output impedance.
7. Antenna-Cable Connectors: Weatherproof.
8. Alarm Interface Devices: Circuit boards, modules, and other auxiliary devices, integral to the transmitter, matching fire-alarm and other system outputs to message-generating inputs of the transmitter that produce required message transmissions.

D. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit or from its own internal sensors or controls and shall automatically transmit signal along with a unique code that identifies the transmitting station to the remote alarm receiving station. Transmitted messages shall correspond to standard designations for fire-reporting system to which the signal is being transmitted and shall include separately designated messages in response to the following events or conditions:

1. Transmitter Low-Battery Condition: Sent when battery voltage is below 85 percent of rated value.
2. System Test Message: Initiated manually by a test switch within the transmitter cabinet, or automatically at an optionally preselected time, once every 24 hours, with transmission time controlled by a programmed timing device integral to transmitter controls.
3. Transmitter Trouble Message: Actuated by failure, in excess of one-minute duration, of the transmitter normal power source, derangement of the wiring of the transmitter, or any alarm input interface circuit or device connected to it.
4. Local Fire-Alarm-System Trouble Message: Initiated by events or conditions that cause a trouble signal to be indicated on the building system.
5. Local Fire-Alarm-System Alarm Message: Actuated when the building system goes into an alarm state. Identifies device that initiated the alarm.
6. Local Fire-Alarm-System Supervisory-Alarm Message: Actuated when the building alarm system indicates a supervisory alarm.

2.16 AUTOCALL SYSTEM INTERFACE

A. When a fire alarm system using existing Autocall XA loop devices requires expansion, the FACU

shall be capable of interfacing to the XA loop via an interface module. This module shall allow the FACU to be selected to function as either the XA loop master controller (head end) or as a Data Gathering Panel as an intelligent device on the XA loop reporting to a remote master controller. Multiple XA Loop Interface Modules can be installed in the FACU allowing a variety of system expansion situations to be satisfied.

2.17 NETWORK SYSTEM INTEGRATOR (NSI)

A. The Network System Integrator shall provide Agency Listed integration capable of communicating the status information from multiple brands and/or vintages of control units onto the fire alarm network for reporting at a central command center location and at other network nodes (panels).

1. Protocol communication interfaces for systems integration that require ongoing protocol development necessary to maintain compatibility and agency listings with new versions of software releases shall not be substituted.

B. The Network System Integrator shall receive primary and secondary power from an alternate source

C. The Network System Integrator shall provide 8 isolated voltage monitor inputs for status communication onto the network

1. Inputs shall be rated to monitor voltages from 10 to 33 VDC
2. Inputs shall be compatible with direct switched or reverse polarity circuits

D. The Network System Integrator shall provide 8 dry contact relay outputs for interface to monitored equipment

1. Each output shall be configurable for normally open or normally closed contact operation.
2. Output contacts shall be rated for 1A @ 24VDC / 25VAC or 0.5A @ 70VAC
3. 7 relay outputs shall be programmable
4. 1 relay output shall be normally energized and dedicated for trouble operation

E. The Network System Integrator shall be capable of maintaining Fire Alarm Network communications with other network nodes (panels) when the monitored interface panel is powered down for service (i.e., repeater mode)

2.18 SYSTEM PRINTER

A. General: Provide a dot-matrix type, listed and labeled as an integral part of the fire alarm system.

2.19 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.

2.20 DEVICE GUARDS

A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.

1. Factory fabricated and furnished by manufacturer of device.
2. Finish: Paint of color to match the protected device.

2.21 SPARE EQUIPMENT

A. The Electrical Contractor shall furnish up to twenty (20) in any combination of fire alarm devices selected by Owner, including but not limited to, smoke, heat, duct, monitor module, control monitor module or audio/visual devices for Owner spare.

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. Existing Fire Alarm Equipment shall be maintained fully operational until the new equipment has been tested and accepted.

C. Equipment Removal: After acceptance of the new fire alarm system, disconnect and remove the existing fire alarm equipment and restore damaged surfaces. Package operational fire alarm and detection equipment that has been removed and deliver to the Owner. Remove from the site and legally dispose of the remainder of the existing material.

D. Water-Flow and Valve Supervisory Switches: Connect for each sprinkler valve required to be supervised.

E. Device Location-Indicating Lights: Locate in the public space immediately adjacent to the device they monitor.

F. 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.

G. Mount outlet box for electric door holder to withstand 80 pounds pulling force.

H. Make conduit and wiring connections to door release devices, sprinkler flow switches, sprinkler valve tamper switches, fire suppression system control units, duct smoke detectors .

I. Automatic Detector Installation: Conform to NFPA 72.

J. 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. Mount end-of-line device in box with last device or separate box adjacent to last device for Class "B" supervision.

E. 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 fire alarm 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.
3. International Municipal Signal Association (IMSA) fire alarm certified.
4. Certified by a state or local authority.
5. Trained and qualified personnel employed by an organization listed by a national testing laboratory for the servicing of fire alarm systems.

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 8 hours' training.

2. Schedule training with the Owner at least seven days in advance.

PART 4 – ADDITONAL SERVICES, GUARANTEE AND FINAL TEST

4.1 GENERAL

A. The contractor shall guarantee all equipment and wiring to be free from inherent mechanical and electrical defects for two (2) year (730 days) from the date of final acceptance.

B. In addition to the equipment shown on the project drawings, and as stated above include ten (10) additional peripheral devices of any type (i.e.: smoke detector, duct smoke detector, heat detector, pull station, monitor module, relay module, control module, speaker/strobe, strobe, etc.). These devices may be installed at the discretion of the local Fire Marshal, the project engineer, or the licensed fire alarm company, upon review and/or testing performed by all. Should these devices not be required to be installed, turn over to Owner as attic stock.

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.

C. Concurrent with the warranty period, the licensed fire alarm contractor shall provide (2) semi-annual inspections of the completed fire alarm system in accordance with the State of Delaware Fire Prevention Regulations. All costs shall be included in the contract amount. No additional fees will be paid by the owner for this service.

4.2 FINAL TEST

Before the installation shall be considered complete and acceptable by the awarding authority, a

test on the system shall be performed as follows:

A. The contractor's job foreman, in the presence of a representative of the owner, and the fire marshal's office shall operate every building fire alarm device to ensure proper operation and correct annunciation at each remote annunciator and control panel.

B. One half (1/2) of all tests shall be performed on battery standby power.

C. Where application of heat would destroy any detector, it may be manually activated.

D. When the testing has been completed to the satisfaction of both the contractor's job foremen and the representatives of the manufacturer and owner, a State of Delaware "Fire Alarm Signaling System Certificate of Installation" shall be completed and signed by the necessary personnel.

E. The contractor shall leave the fire alarm system in proper working order, and without additional expense to the owner, shall replace any defective materials or equipment provided by him under this contract within two (2) years (730 days) from the date of final acceptance by the awarding authority. Warranty work shall be completed during normal business hours, a maximum of 24 hours after notification of the service request.

F. Provide service response within (1) hour during a "false alarm" condition.

4.3 AS BUILT DRAWINGS, TESTING, and MAINTENANCE INSTRUCTIONS

4.4 <u>As Built Drawings</u>

1. 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. <u>Operating and Instruction Manuals</u>

1. 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 it's representatives shall be 4 hours, performed during normal business hours.

C. <u>Testing Frequency Instructions</u>

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 28 0721

SECTION 28 0724
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). Simpex 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.

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 puhbutton 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 28 0724

SECTION 28 0725
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 7412gV2 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 sub-sections 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 a minimum two (2) years (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 28 0725

SECTION 28 0727

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 2-year product warranty from date of substantial completion. 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 by 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 Battery

   The 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
   b. Controllers
   c. Doors
   d. Readers
   e. Input/Output Modules
   f. Inputs

g. Outputs
h. Elevators
i. Events
j. Areas
k. Intrusion Zones
l. Keypad Commands

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

The SMS shall support the following controller hardware:

1. GENERAL: The access control system design is based on the iSTAR Ultra 32-reader Network Door Controller by Software House. Provide Network Door Controllers as indicated on the project plans, located centrally in relation to the doors controlled, to minimize wiring. Each iSTAR Ultra shall be an independent, stand-alone network controller, providing local access control decision-making, a local database of cardholders, and alarm and event buffering in the event communications to the host is lost. The iSTAR Ultra shall serve as the data collection and communications interface between the System Server and the various field devices such as card readers, wireless locksets, alarm inputs and control outputs. Systems that rely on a host server for the access control decision will not be considered.

   The system design, where noted on the plans, shall also utilize IP-ACM Ethernet door modules to act as distributed door interface units. Each IP-ACM shall be able to control either one or two doors, and shall rely on the iSTAR Ultra Network Door Controller for the access control

decision. The Network Door Controller shall support up to 32 readers, including readers attached to IP-ACM units.

a. Manufacturer: Network Door Controllers and Ethernet Door Modules shall be as manufactured by Software House, a unit of Tyco Security Products, 6 Technology Park Drive, Westford, MA 01886 (+1-978-577-4000). No substitutions are allowed.

b. Warranty: The Network Door Controllers and IP-ACM Ethernet Door Modules shall be warranted against defects in materials and workmanship for a period of at least 5 years from date of manufacture.

c. Regulatory Approvals:

(1) The Network Door Controllers and Ethernet Door Modules shall be tested by and certified by Underwriters Laboratories (UL) to meet the following regulatory requirements:

(a) UL/cUL 294, Standard for Access Control Systems and Equipment

(b) UL/cUL 1076, Standard for Proprietary Alarm Units

(2) The Network Door Controller and Ethernet Door Module shall also meet the following regulatory requirements

(a) FCC Part 15 Class A

(b) CE

(c) IEC 60950

(d) C-Tick

(3) The controller shall incorporate Advanced Encryption Standard (AES) 256-bit encryption for controller-to-host and controller-to-controller communications. The encryption shall be certified by the National Institute for Standards and Technology (NIST) as compliant with the U.S. Government's Federal Information Processing Standard (FIPS) 197.

(4) The controller shall be tested and certified by the National Institute for Standards and Technology (NIST) as compliant with the U.S. Government's Federal Information Processing Standard (FIPS) 140-2, Cryptographic Module Validation Program (CMVP). The controller shall be rated at FIPS 140-2 Level 2 or higher.

(5) The Controller shall communicate to its Ethernet Door Modules using AES 256-bit encryption.

(6) The controller shall be manufactured in strict compliance with the European Union's Directive 2002/95/EC on the Restriction of Hazardous Substances (RoHS), and shall display a RoHS mark on the exterior of its enclosure.

2. NETWORK DOOR CONTROLLER HARDWARE

a. Processor and Memory

(1) The Network Door Controller's microprocessor shall be of sufficient speed and power to provide on-board AES 256-bit encryption without use of an external encryption device, while providing access decisions within 500 ms on a fully loaded system. The controller shall have at least 2GB of on-board memory for cardholder and event storage. There shall be at least 16GB of on-board FLASH memory that shall be used for boot code and operating system code, and for memory backup.

(2) The controller shall be able to locally store at least 500,000 card holders, using five cards/person and with 10 clearances/person, while also providing room for a transaction buffer of 10,000 alarms and events (minimum) in case communications to

the host is lost.

b. Memory Retention and Real Time Clock Backup: The Network Door Controller must include automatic means to back up the system memory, including card holder records, configuration information, and alarm/event information, to onboard non-volatile flash memory in the event of AC power loss or Battery Low alarm. During the power interruption, the system's real time clock shall be backed up using a lithium coin cell battery such that the time is current when power is restored.

c. Dual Ethernet Network Ports: The Network Door Controller shall have two on-board 10/100/1Gb Ethernet ports, using standard RJ-45 connectors. The network ports must support full duplex communications. The controller must provide visual LED indication of transmit and receive activity for the Ethernet communications port. Controllers that do not offer full duplex 1Gb connectivity will not be accepted.

   (1) Secondary Communications: Using the dual network ports, the controller must support a primary network communications path and secondary communications path to the system server. Failover operation is described later in this document.

d. Field I/O Wiring Modules (ACMs): The Network Door Controller shall provide terminations for field wiring through the use of modular ACM boards (Access Control Modules). Each module shall support up to 8 readers and 8 doors, and a Network Door Controller may utilize either one or two ACMs, for a total of 16 readers.

   (1) Upgrades: An eight-reader Network Door Controller shall be able to easily upgraded in the field to a 16-reader controller, through the addition of a second ACM board.

   (2) USB Communications: Communications from each ACM to the Network Door Controller's GCM (General Control Module) shall be made using a standard USB connection.

e. Ethernet Door Modules (IP-ACMs): Ethernet Door Modules shall be located near the doors they control, to reduce the wiring needs of the access control system. Each Ethernet Door module shall provide terminations for the field wiring needs of one or two access control doors.

   (1) Network Connectivity: The Ethernet Door Module shall have one Ethernet port, for TCP/IP communications to the Network Door Controller. The Ethernet port shall support GigE Ethernet compatibility, as well as 10/100bT Ethernet. Door modules that do not support GigE connectivity shall not be considered. Communications to the Network Door Controller shall be encrypted with AES 256-bit encryption.

f. Wireless Locksets: The Network Door Controller shall provide monitoring and control of up to 32 wireless locksets, using a local RS485 bus to interface to the wireless lockset hub network. The Network Door Controller shall support either the Schlage AD300 and AD400 series of locksets, or the ASSA ABLOY Aperio series of locksets. When ACM I/O modules are used, the number of wireless locksets supported shall be reduced such that the overall reader count remains at 32 per Network Door Controller.

g. Power Requirements: The Network Door Controller shall be powered from a low voltage 12VDC power source, within a range of +/- 15%. 12VDC power is used to power the controller electronics, plus, reader power and RS485 bus power.

   (1) Lock Power Management: In addition to system power, each ACM I/O module shall be capable of managing and controlling lock power, such that separate individual fused relay boards or lock isolation relays shall not be required. Each ACM shall provide two lock power inputs in addition to system power; each output relay on the ACM shall be configurable via jumper to use lock power feed 1, lock power feed 2, or dry contact.

Lock power feeds may be either 12VDC or 24VDC. All power feeds to outputs shall be power limited via resettable PTC devices.

(2) Power Requirements Design: The system designer shall be responsible for calculating the overall power requirements for the Network Door Controller, including locking devices, readers, annunciators, and PIR exit devices. A power calculation spreadsheet shall be used to verify system power requirements, and a safety factor of 50% shall be used when sizing power supplies.

h. Wall Mount System Enclosure: The Network Door Controller shall be housed in a locking 18 gauge steel enclosure, suitable for wall mounting in accordance with UL 294. All cabinet locks shall be keyed alike. The cabinet shall be suitably sized to allow installation of the controller and associated field wiring. The cabinet shall measure 25" in height by 22" in width and 5" in depth. There shall be a power indicator on the door which shall be visible when power is applied to the controller. A single, Normally Closed (NC) tamper switch shall be incorporated into the door. There shall be at least 12 knockouts on the enclosure of various sizes to facilitate conduit and wire routing.

(1) Expansion: The wall mount enclosure shall be sized to accommodate up to two ACM I/O boards.

i. Rack Mount System Enclosure: Alternatively, the Network Door Controller shall be able to be mounted in a standard 19" rack, using standard rack mounting hardware. A modular rack mounting arrangement shall be provided such that the GCM module is housed in a separate rack enclosure that is 2U high (3.5"), while each ACM is housed in a 4U enclosure (7" in height). Each rack enclosure will be made of 18 gauge galvanized steel, painted black. The enclosures shall be suitably sized to allow installation of the controller and associated field wiring. A single, Normally Closed (NC) tamper switch shall be incorporated into the door.

(1) Tamper Switches: Each rack mount enclosure shall have its own NC tamper switch, incorporated into the body of the enclosure and activated whenever the cover is removed or partially removed.

j. Environmental Requirements: The Network Door Controller shall be capable of operation in temperatures between 0º and 50º C (32º - 122º F), and within humidity levels between 5% and 95%, non-condensing.

k. Reader Inputs: The controller shall provide for direct connection of up to 16 Wiegand read heads. The read heads connected to these ports shall conform to the industry standard Wiegand Output format and shall support multiple card technologies including contactless smart card, Wiegand, proximity, barium ferrite, bar code and biometrics. Wiegand readers directly connected to the controller may reside up to 500 ft. from the controller with the proper 18 AWG wiring. Any direct Wiegand reader port may be disabled and an RM series reader shall be connected in its place, through the reader bus, to extend the distance from the controller to the read head. Wiegand reader inputs must be capable of receiving and decoding a bit stream of at least 256 bits.

(1) LED Control: In addition to accepting card data from the read heads, the controller shall control the LEDs at the reader, supporting industry standard 2-wire or 1-wire control. The controller shall also provide a signal line to control an external beeper at the reader with an active low going signal. The LED control shall support three LEDs - red, amber and green. The System Server shall support the configuration of these LEDs such that certain LEDs shall illuminate or not illuminate or pulse to indicate various System status conditions. These LEDs shall indicate the following status conditions as a default:

- On-line Indication — Amber LED on steady
- Off-line Indication — Red LED on steady
- Card Accepted — Green LED pulses for door open time
- Card/PIN — Amber LED pulses to enter PIN. Subsequent red/green LEDs mimic card input
- Alarm Condition — All LEDs pulse in alternating pattern

(2) Wiegand Keypad Support: The direct Wiegand reader ports shall support Wiegand readers with integrated Wiegand output keypads. The supported data format shall conform to industry standard 4 bit or 8 bit (4 bits plus 4 bits complemented) Wiegand keypad data.

(3) Power for Readers: The controller shall provide +12VDC power for each reader, up to 1.5A each, on separate wiring terminals.

(4) Support for RS485 Readers, with Display/Keypad: The controller shall support RS485 readers, to accommodate door control at distances greater than the 500 foot Wiegand distance limit, and to provide support for Software House RM series readers with a custom user display. The controller shall support up to 16 RM series card readers, and can also be configured to use a mix of Wiegand and RM readers, such that the overall reader count from Wiegand and RS485 readers does not exceed 16.

(5) Support for RS485 OSDP Secure Channel Readers: The controller shall support OSDP (Open Supervised Device Protocol) RS485 readers, to provide support for open standard readers that conform to the OSDP 2.1.6 standard, as published by the SIA (Security Industry Association). The unit must support OSDP secure channel, utilizing AES 128-bit encryption and supporting automatic custom key management.

l. Supervised Inputs

(1) Twenty four (24) Class A Supervised inputs shall be provided on each ACM module, providing three inputs per reader. All supervised inputs in the system shall be field-configurable to accept either 1K, 5K or 10K ohm terminating resistor networks which may be configured to accept Normally Open (NO) or Normally Closed (NC) switches or contacts. Each EOL resistor network shall be configured such that the circuit reports unique messages for a secure circuit, alarm condition, and an open or shorted input (supervision alarm). Each input must also be capable of reading a non-supervised circuit.

(2) Each two-wire input must be able to be configured individually for its supervisory circuit type.

(3) Each two-wire input must be terminated on its own connector, and must not share a connector with another input.

(4) The Monitoring Application Interface shall provide the current status of the inputs and shall log changes in input status. Supervised inputs shall be able to be taken offline for diagnostic purposes and each input shall support being linked directly to an output or to a system event. All input activations shall be reported to the Monitoring Application and stored in the Historical Journal on the System Server.

m. General Inputs: The Network Door Controller shall provide dedicated, normally-closed inputs for:

(1) Enclosure Tamper: In a wall-mount cabinet, the tamper input on the GCM shall be pre-wired to the enclosure door to report opening of the door as a tamper event. In a rack-mount enclosure system, each enclosure's tamper switch shall be pre-wired to

either the GCM or ACM tamper input.

(2) Power Fail: A dedicated input shall be provided for a power failure alarm. When using an external DC power supply to power the unit, this input shall be wired to the power supply's alarm output

(3) Low Battery: A dedicated input shall be provided for a low battery alarm. When using external DC power supply to power the unit, this input shall be wired power supply's low battery alarm output

n. Outputs: The Network Door Controller shall provide 16 separate outputs on each ACM module, configurable through on-board jumpers as either "wet-lock1" (power sourcing), "wet-lock2" (power sourcing) or as dry contact form C relays. The outputs shall be used to control door locks, local annunciators, and other output devices as required.

(1) Output Protection and Power Ratings

(a) Each output shall be individually protected with a PTC resettable fuse, transzorbs and snubbers so that power can be directly provided to locking devices without damage to the controller.

(b) When sourcing power to the outputs, one or both lock power inputs may be used. Outputs shall be able to provide at least 0.75A at 12VDC or 24VDC.

(c) Eight of the output relays shall be socketed, designed to control lock circuits, and shall be rated for 5.0A, 30VAC/DC when used as a dry contact control relay.

(d) The other eight relays shall be non-socketed, designed to control local door annunciator devices, and shall be rated for at least 1.0A at 30 VAC/30 VDC when used as a dry contact control relay.

(e) The controller shall provide a LED for visual indication of each output's status.

(f) Each output must be terminated on its own connector, and must not share a connector with another output.

(g) The Monitoring Application Interface shall provide the current status of each output and shall allow the manual activation of each output individually or in user-defined groups for diagnostic purposes. All output activations shall be reported to the Monitoring Application and stored in the Historical Journal on the System Server.

(2) Fire Alarm Interlock

(a) Each lock output shall be capable of being controlled directly from a fire alarm input on the ACM board, based on a local dip switch setting for each output. When the fire alarm input is activated, the lock output shall be controlled to the door open state, if its fire alarm dip switch was enabled for that lock. Fire alarm control shall be hard-wired and not dependent on any software or firmware function to operate. Fire alarm functionality shall be tested and listed per UL.

(b) A separate fire alarm key switch latch input shall be provided. This input shall be used if manual intervention is required after a fire alarm before the locks are able to return to their normal (locked) condition. The ACM module shall have a key switch enable switch to enable this feature.

o. Local Display

(1) The controller shall include a local, on-board two-line LCD for status and field diagnostic messages. Provide local switches on the controller to set the LCD messaging and diagnostic modes.

(2) For normal operations, the LCD shall be configured to display status messages. For troubleshooting operations, the LCD shall be configured to display diagnostic messages for readers and card data, inputs, outputs, network ports and other connected devices.

(3) As a minimum, status messages shall include:

- iSTAR boot information
- Date and time
- Firmware version
- Controller status information.
- Configured power and measured power
- IP address and MAC address of controller
- Host connectivity status

(4) The LCD shall also provide diagnostic information for:

- Cards/Readers – display raw card data, number of bits, reader number
- Inputs – display changes in input state
- Outputs – test each output in sequence
- Ethernet ports – test operation of the port

p. I/O Expansion

(1) The Network Door Controller shall support input and output expansion, through the use of RS485-based input/output modules. Each ACM module shall support up to 16 I8 modules, each providing eight supervised inputs, and up to 16 R8 eight-output form C relay modules. Form C relays shall be rated at 2A resistive and 1A inductive at 30VAC/DC.

(2) The controller's wall mount enclosure shall be able to accommodate up to four modules mounted internally, without need for an external enclosure of any kind.

(3) The controller must provide, at least, eight RS-485 expansion ports. Each port must have LED indication of transmit and receive communications activity. End-of-line (EOL) termination resistors shall be provided for each port to satisfy RS-485 multi-drop requirements. The termination resistors must be selectable, by switch, to provide the possibility of a "Y" wiring arrangement.

(4) Each RM reader expansion bus must provide +12VDC power to its associated devices, through on-board power terminals. Each RM device may be powered from the controller, or through a local +12VDC source.

q. Wiring Connectors: All connectors shall be screw down type and pluggable, to facilitate field replacements and simplify testing. Connector spacing shall be such that connectors cannot be placed on the wrong wiring terminals.

3. Network Door Controller Software

a. Firmware and OS: The Network Door Controller shall utilize a standard off the shelf Linux operating system, including kernel and base OS image. Firmware updates to the controller shall include updates to the OS if applicable, including security patches. It shall not be necessary to independently manage updates to the OS outside of the access control application.

b. Communications: The Network Door Controller shall utilize standard Ethernet network connectivity for communications, to the host server or to other network controllers.

Controllers shall be wired at any point on a Local Area Network (LAN)/Wide Area Network (WAN) via industry standard Ethernet utilizing the TCP/IP protocol. The Network Door Controllers shall be able to communicate back to the System database server through industry standard network switches and routers and shall not be required to reside on the same subnet as the System Server. Any activity or event within the controller network shall be routed to any client workstation(s) on the network, regardless of the controller that handles the activity. The System Server shall manage any message routing issues, thus isolating the subsystem applications from network-specific communication details.

The controller to System Server communication, and controller to controller communication within the same cluster, shall include authentication and a minimum of 256-bit AES encryption.

Upon losing and then restoring communications between the controller and the System Server, database synchronization between the System Server database and the local database in each controller shall be fast and efficient. When communications are restored, database synchronization shall occur immediately and without System Operator intervention. Any changes made to the System Server database while the controller was off-line shall also be simultaneously downloaded to all required controller databases.

(1) Protocols

(a) Communication between the System Server and the controller, and from controller to controller, is via TCP/IP only.

(b) The controller shall support DHCP. Each controller may be configured to accept an IP address and device name from local DHCP (Dynamic Host Configuration Protocol), WINS (Windows Internet Naming Service) or DNS (Domain Name System) servers.

(c) The controller shall have two 10/100/1000bT Ethernet (RJ-45) ports on-board and shall not require external devices to connect to the network.

(2) Clustering

(a) The Network Door Controllers shall support peer-to-peer communications, without the need for host intervention. A cluster is a user-defined grouping of Network Door Controllers used to define peer-to-peer communications.

(b) Peer-to-peer communications within a cluster shall be used for input/output linking between controllers, and for anti-passback control within a cluster.

(c) Each cluster has a master controller. The master is the primary connection between the cluster and the System Server. Communication from the System Server to the master shall be through a TCP/IP supported physical medium.

(d) The other cluster controllers are referred to as members. Member controllers do not communicate directly to the System Server or to each other; rather their communication path to the System Server and to each other shall be through the master. Communication within a cluster is always through a TCP/IP supported physical medium.

(e) Each master controller shall support an alternate Ethernet communications path to the System Server. In the event of a primary communications path failure, the master shall immediately attempt to utilize the secondary or alternate communications path. The alternate Ethernet path can be configured to use a different host IP address and subnet.

(3) Polling: The Network Door Controllers shall support peer-to-peer communications, without the need for host intervention. Communication between the System Server and the controller shall be asynchronous. The Network Door Controller shall not require any poll messages between the System Server and the controller. Messages shall only be transmitted when required and messages can be initiated by any controller or by the System Server. The controller shall transmit a network heartbeat to the System Server to satisfy UL requirements.

(4) AES Encryption and Key Management

(a) The controller to System Server communication, and controller to controller communication within the same cluster, shall include authentication and a minimum of 256-bit AES encryption. The controller shall offer both default key management and custom key management.

(b) For a secure environment, the controller must be able to accept and use a customer-supplied custom encryption key, supplied either from the host or from the controller. The controller must use a public key infrastructure (PKI) arrangement and certificates to authenticate keys between the host and the controller. The controller shall provide an on-board USB port to load a local encryption key.

c. Common System Services

(1) System Watchdog: The System Watchdog shall constantly monitor all internal processes and if it detects a problem, it shall reboot the controller. A hardware watchdog shall also run and reboot the controller if the system software fails to strobe it. The controller's internal clock shall be updated by the controller's real-time clock upon restart.

(2) Software Update Service: The system shall provide the ability to update the controller firmware stored in FLASH remotely from the host, directly within the C•CURE 9000 user interface. If the update image becomes corrupted, the controller can fall back to an original boot image. The boot image shall restart the controller and inform the host to re-send the update image. This feature allows the controller firmware to be easily upgraded to add new features.

d. Event Handling Services: The controller system firmware shall provide a service that will serve as a clearinghouse for all activities generated on a Network Door Controller. The System Server shall download a list of action definitions and a list of events to each controller. The system software shall provide an interface for reporting activities or events in real time as they occur.

(1) Event Linking: Event linking shall tie an activity on one controller to the triggering of an action on the same or different controller. The Server Controller shall support three types of event linking:

(a) Local Event Linking: When the source device and the target device are linked through an activity on the same controller, local event linking shall occur.

(b) Cluster Event Linking: When the source device and the target device being linked are on different controllers in the same cluster, cluster event linking shall occur. The transmission of the action request from one controller to another shall occur (routed through the master controller) with no System Server intervention.

(c) Global Event Linking: When the source device and the target device being linked are on different clusters, global event linking shall occur. This cross-cluster linking will require that the action request be routed through the System Server. The event link definitions shall be created on the System Server and shall be

downloaded to the appropriate controllers. The System Server shall also insure that the event link definitions are valid and that there are no recursive links.

(2) Action Scheduling: The system software shall provide an action scheduling service that will execute actions on devices residing on the same or other controllers at a predefined time, frequency and time interval. The action definitions shall be the same System Server-defined actions utilized by event linking. The actions and the action schedule shall be defined by the System Server software and shall be downloaded to the appropriate controllers.

(3) Offline / Online Reporting: The system shall provide a mechanism to report activities to the System Server for display, reporting and archiving. If a System Server is not currently connected to the cluster of controllers, the activity reports will be buffered until the System Server reconnects to the cluster. Should the user-configured, activity buffer limit be exceeded before the System Server reconnects, the first in first out rule shall apply. Provide a minimum of 10,000 events in the offline buffer.

(4) Time Management Services: The system shall provide a service to manage user-defined time periods. These time periods shall be defined on the System Server and downloaded to all controllers. The time management services shall also ensure that all controllers have a synchronized time clock.

e. Access Control Functionality: The controller shall perform basic access control operations with or without communications to a host server, including unlocking a door based on a valid credential, unlock based on a valid PIN, unlock based on card plus PIN, unlock based on schedule, unlock based on a pre-defined sequence or event, and unlock based on a manual action initiated by a system operator. In addition, the Network Door Controller shall be capable of the following:

(1) Custom Defined Card Formats: The user shall be able to define custom card formats, up to 10 per controller, and each format shall be able to be at least 256 bits in length. The user shall be able to define and use government card formats such as the 200-bit GSA format with HMAC.

(2) Elevator Control: The controller shall be able to perform elevator control, using either inputs and outputs hard-wired to the elevator control system, or, using a network interface through the host server. Card readers may be located in the elevator lobbies or elevator cabs. Upon a valid card read, the controller shall decide which floors the person is authorized for.

(3) Intrusion Zones: Doors on the controller shall be able to be defined as intrusion zones that are armed and disarmed by various methods through a RM keypad/display reader.

Inputs on the controller shall be able to be defined as included in intrusion zones, and may be defined as 24-hour inputs, such as glass-break sensors, or as inputs that may be shunted during a time period, such as motion sensors.

(4) Double Swipe Custom Event: The controller shall be capable of performing a pre-defined sequence of events if two duplicate card reads are seen within a certain period of time. It must be possible to select which personnel will activate the double swipe feature on each door.

f. Diagnostic Web Server: The Diagnostic Web Server shall generate real-time operational and diagnostic information on a Network Door Controller to be viewed by system installers, troubleshooters and tech support personnel from a standard web browser, such as Internet Explorer. This web server, residing on each controller, shall answer requests from a standard web browser and shall generate and serve up HTML pages that indicate

controller status and diagnostic information.

(1) Compatibility: The Diagnostic Server shall be compatible with standard browsers, such as Internet Explorer, Google Chrome and Mozilla Firefox.

(2) Functional Requirements: The Diagnostic Web Server shall query the appropriate controllers to determine the following information and shall display it in an organized fashion to the user via a web browser.

(a) Total and Available Memory (RAM): The Diagnostic Web Server shall display the total amount of memory (in bytes) on the controller and the amount of memory (in bytes) that is currently free.

(b) Current Time Information: The Diagnostic Web Server shall display the controller's current time and time zone.

(c) Boot Time: The Diagnostic Web Server shall display the time at which the controller was last rebooted.

(d) Firmware and Operating System Versions: The Diagnostic Web Server shall display the Firmware Version and build number and the operating system Version Number.

(e) MAC and IP Address Information: The Diagnostic Web Server shall display the controller's unique MAC Address as well as its IP Address.

(f) Controller Type (Cluster): The Diagnostic Web Server shall display the controller type within the cluster – Master or Member.

(g) Connection Status: The Diagnostic Web Server shall display the controller's current connection status with its parent (System Server or Master Controller).

(h) Parent Information: The Diagnostic Web Server shall display the hardware MAC and IP Addresses of its parent (System Server or Master Controller).

(3) Security: The Diagnostic Web Server shall support multiple simultaneous users and should have minimal impact on the normal operation of the controller. The Diagnostic Web Server shall utilize a standard security scheme that requires a user to log in using a password that shall be set via the System Server or the iSTAR Configuration Utility (ICU).

It shall be possible to disable the diagnostic web server if desired.

(4) Database Information: The Diagnostic Web Server shall display all controller database information, along with the number of records contained, the amount of memory (in bytes) utilized and the percentage of memory that each one consumes.

(5) Run-Time Diagnostics/Debug Information: The user shall have the ability, via the web browser, to enable the output of real-time debugging information. This information shall be displayed on the browser. The information may also be output via the serial Debug Port of the controller and can be viewed (and captured) by standard tools such as HyperTerminal.

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.

3.4 SPARE EQUIPMENT

A. This Contractor shall provide the district two hundred (200) additional programmable security cards, in addition to the required project amount, as attic stock.

END OF SECTION 28 0727

SECTION 28 0728

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, Ipix 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.

SECTION 3 – WARRANTY

3.1 Provide a 2-year warranty on all equipment, parts, and labor. Warranty to start from date of substantial completion.

END OF SECTION 28 0728

SECTION 32 3119
DECORATIVE METAL FENCES AND GATES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Decorative steel fences.

B. Matching steel sliding gates.

C. Gate operators and controls.

1.02 RELATED REQUIREMENTS

A. Section 03 3000 - Cast-in-Place Concrete.

1.03 REFERENCE STANDARDS

A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2015.

B. ASTM F2408 - Standard Specification for Ornamental Fences Employing Galvanized Steel Tubular Pickets; 2016.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to start of work of this section; require attendance by affected installers.

1.05 SUBMITTALS

A. Product Data: Submit manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.

B. Shop Drawings:
   1. Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, gates, and schedule of components.
   2. Foundation details, concrete design mix and reinforcing schedule for anti-ram barrier system.

C. Installer's Qualification Statement.

D. Manufacturer's Warranty.

1.06 QUALITY ASSURANCE

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

B. Installer Qualifications: Experienced with type of construction involved and materials and techniques specified and approved by fence manufacturer.

1.07 DELIVERY, STORAGE AND HANDLING

A. Store materials in a manner to ensure proper ventilation and drainage. Protect against damage, weather, vandalism and theft.

1.08 WARRANTY

A. Finish: 10 years.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Decorative Metal Fences:
   1. Ameristar Perimeter Security, USA: www.ameristarfence.com.
   2. Substitutions: See Section 01 6000 - Product Requirements.

2.02 FENCES

A. Fences: Complete factory-fabricated system of posts and panels, accessories, fittings, and fasteners; finished with electrodeposition coating, and having the following performance characteristics:
   1. Capable of resisting vertical load, horizontal load and infill performance requirements for fence categories defined in ASTM F2408.

B. Electro-Deposition Coating: Multi-stage pretreatment/wash with zinc phosphate, followed by epoxy primer and acrylic topcoat.
   1. Total Coating Thickness: 2 mils, minimum.

C. Steel: ASTM A653/A653M; tensile strength 45,000 psi, minimum.
   1. Hot-dip galvanized; ASTM A653/A653M, G60.
   2. 62 percent recycled steel, minimum.

2.03 WELDED STEEL FENCE

A. Provide fence meeting requirements for Industrial class as defined by ASTM F2408.

B. Fence Panels: Fusion welded; 8 feet high by 8 feet long.
   1. Panel Style: As shown.
   2. Attach panels to posts with manufacturer's standard panel brackets.

C. Posts: Steel tube.
   1. Size: 3 inches square by 12 gage, 0.109 inch, with manufacturer's standard cap.
   2. Post Cap: Flush plate.

D. Rails: Manufacturer's standard, double-wall steel channel 1-3/4 inch square by 12 gage, 0.1094 inch with pre-punched picket holes.
   1. Picket Retaining Rods: 0.125 inch galvanized steel.
   2. Picket-to-Rail Intersection Seals: PVC grommets.

E. Pickets: Steel tube.
   1. Spacing: 3-3/4 inch clear.
   2. Size: 1 inch square by 18 gage, 0.0478 inch.
   3. Style: Pickets with finial extend above top rail.
   4. Finial: Spear point.

F. Flexibility: Capable of following variable slope of up to 1:2.

G. Gates: Vehicular (single sliding) gate.
   1. Ornamental Picket Cantilever Gate.
   2. Match design of fence.
   3. Size: As shown.
   4. Product: TransPort II as manufactured by Ameristar Perimeter Security, USA

2.04 ACCESSORIES

A. Gate Operator:
   1. 1 HP continuous-duty motor:

a. Maximum gate width: 22-ft. (1 HP).
b. Maximum gate weight: 800 pounds* (1 HP).
2. 1 HP continuous-duty motor.
3. 115, VAC.
4. Class I, II, III and IV applications.
5. Dimensions: 18.38"W x 31.63"H x 23.25"D
6. Adjustable, no maintenance magnetic limits.
7. Overlap feature for bi-parting swing gate operation.
8. Simple connection for secondary operator in bi-parting applications.
9. Selectable shadow/reverse loop function.
10. Magnetic lock power provided.
11. Ports for plug-in loop detectors.
12. Three 115 VAC convenience outlets.
13. Gate tracker reporting output.
14. Programming switches.
15. Built-in reset switch.
16. Built-in power On/Off switch.

B. Gate Controls:
1. Key pad control.
2. AI Phone.
3. Knox Box.

PART 3 EXECUTION

3.01 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

A. Clean surfaces thoroughly prior to installation.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Set fence posts in accordance with the manufacturer recommended spacing.

C. When cutting rails immediately seal the exposed surfaces by:
1. Removing metal shavings from cut area.
2. Apply zinc-rich primer to thoroughly cover cut edge and drilled hole; allow to dry.
3. Apply two coats of custom finish spray paint matching fence color.
4. Failure to seal exposed surfaces in accordance with manufacturer's instructions will negate manufacturer's warranty.

D. Space gate posts according to the manufacturers' drawings, dependent on standard out-to-out gate leaf dimensions and gate hardware selected.
1. Base type and quantity of gate hinges o the application; weight, height, and number of gate cycles.
2. Identify the necessary hardware required for the application on the manufacturer's gate drawings.
3. Provide gate hardware by the manufacturer of the gate and install in compliance with manufacturer's recommendations.

3.04 ERECTION TOLERANCES

A. Maximum Variation From Plumb: 1/4 inch.

B. Maximum Offset From Indicated Position: 1 inch.

C. Minimum Distance from Property Line: 6 inches.

3.05 CLEANING

A. Leave immediate work area neat at end of each work day.

B. Clean jobsite of excess materials; scatter excess material from post hole excavations uniformly away from posts. Remove excess material if required.

C. Clean fence with mild household detergent and clean water rinse well.

D. Touch up scratched surfaces using materials recommended by manufacturer. Match touchup paint color to fence finish.

3.06 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair, or replace damaged products before Date of Substantial Completion.

END OF SECTION