SPECIFICATIONS

FOR

THE NEW WHITEHALL ELEMENTARY SCHOOL

APPOQUINIMINK SCHOOL DISTRICT

NEW CASTLE COUNTY, DELAWARE

Project # 1621

Appoquinimink School District

THE WORLD IS OUR CAMPUS

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PROJECT MANUAL – VOLUME 3
Divisions 21 thru 33

BID DOCUMENTS – October 13, 2017

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SECTION 210170: 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 5/31/17 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.

2.12 PREACTION SUPPRESSION SYSTEM

A. The system shall be a complete and operating, supervised, single interlocked, controlled electric release with riser-mounted air compressor system.

B. The equipment shall be a total Viking System that shall include all system components, devices, valves, fittings, control panel, compressor, etc., for a field installation.

C. The installation shall be in strict conformance with the manufacturer's written instructions and schematic diagrams.

D. Electrical power wiring shall be provided to the control panel and to the compressor by the Electrical Subcontractor. All wiring beyond that point shall be considered control wiring, and shall be the responsibility of the Fire Protection Contractor. This includes detector wiring between the heat detectors and the control panel.

E. Heat detectors for the system are <u>not</u> included in the Viking package. The detectors shall be furnished by the fire alarm Subcontractor.

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

D. Wet-Pipe Sprinkler Branch and Standpipe Piping:

1. NPS 2-1/2” and Larger: Standard weight 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:

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 210170

SECTION 210171: 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 50 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 and Transfer Switch
   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
   Joslyn/Clark
   Tornatech
   Metron
   Eaton

3. Jockey Pump

   Aurora (Basis of Design)
   Grundfos

4. Flow Meter System

   Aurora/GVI
   Aeroquip
   Victaulic
   Viking

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 4-383-7C 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: 23 HP maximum, 3500 RPM vertical shaft wound for 480 volts, 3 phase, 60 (50) 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. Flow metering device

4. Eccentric tapered suction reducer

5. Concentric tapered discharge increaser

6. Discharge tee

7. Base elbow

8. Hose valves

9. Caps and chains

10. Hose valve header

11. Blind flange

12. Suction and discharge pressure gauges, 4-1/2” dia. dial with snubber, valve cock and lever handle.

13. Main relief valve (optional for electric)

14. Circulation relief valve

15. Relief cone – enclosed (optional for electric)

16. Automatic air release valve

17. Splash shield (electric drive only)

18. Balldrip valve

19. 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) (primary resistor) (partwind) (limited service) (wye delta) 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 ____ 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 110 p.s.i.g. and out at 120 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.
    d. Controller power transfer switch position.

B. Provide the controller with a U.L. (Underwriters Laboratories) Listed and F.M. (Factory Mutual) Approved automatic power transfer switch for fire pump service. The power transfer switch shall be of the same manufacturer of the controller, fully compatible with the fire pump controller. Alternate power to the switch shall be from the facilities emergency back-up power generator system and shall be complete with all the requirements in accordance with NFPA 20 for power transfer switches.

2.5 PRESSURE BOOSTER (JOCKEY) PUMP

A. Pump shall be a centrifugal close-coupled, vertical type pump, cast iron, bronze fitted with stainless steel shaft, mechanical seals, impeller wear rings.

B. The motor characteristics shall be based on a vertical open dripproof motor for 208 volts, 3 phase, 60 cyce, 3600 RPM, complete with energy efficiencies and power factor corrections as noted in Section 220010.

C. The gpm and TDH selection shall be based on the proposed design capacity related to the fire pump and requirements of the most remote standpipe as calculated.

D. Jockey pump controller shall be complete with fusible disconnect starters, control circuit transformer, pressure switch start button and selector switch, all prewired and housed within a NEMA 2 enclosure.

2.8 FIRE PUMP FLOW METER TEST SYSTEM

A. Furnish and install venturi fire pump flow meter system as manufactured by Aeroquip Corporation or equal. This shall be a coordinated system, including individual Venturi Flow Stations and fixed mounted Master Meter, supplied by one manufacturer.

B. The primary flow element shall be a venturi selected from manufacturer's engineering data to permit prescribed flow at a minimum head loss. For maximum accuracy and minimal length of 1.6x pipe diameter. The beta ratio shall be selected to allow for a differential pressure compatible with the meter as specified herein and ensure a properly calibrated system accuracy within 2% throughout the entire range. This accuracy shall be obtained with as little as five (5) pipe diameters of straight pipe upstream and two (2) diameters downstream from the Venturi. The Venturi shall be furnished with two (2) accurately located built-in sensing taps, nipples, shut-off valves and quick connect couplings. Venturie shall be complete with identification tag on chain, giving P/N, pipe size, beta ratio, Venturi style, flow rating, date of manufacture and FM approval.

C. Venturi station shall consist of one-piece cadmium-plated cast steel with weld neck or flanged ends. If the size is larger than 8", it shall be cadmium-plated fabricated steel, with weld or flanged ends.

D. Venturi size and beta ratio shall be selected to accurately measure throughout the range of 50% to 200% of the rated capacity of the fire pump for which the flow meter shall be used.

E. The indicating meter shall be fixed mounted type with 6" round dial, 270 deg. indication. It shall be the dual rupture-proof liquid filled bellows type with integral temperature compensation. The meter shall have over-range protection in either direction equal to the working pressure equivalent of the instrument housing (250 psig @ +250° F). The accuracy of the meter shall be no less than 0.5% full scale. The meter case shall be waterproof and coated with appropriate paint. It shall have external zero and range adjusting screws and life-long lubrication. Scale shall be calibrated to read directly in gpm, and shall be scaled to read up from 0-200% of rated pump capacity.

F. Stationary or fixed mounted meters shall be furnished with necessary mounting brackets, bleed-off and shut-off valves, color coded connectors, fittings and assembly piping.

G. Meter shall have a label attached identifying the meter number and range.

2.9 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 210171

SECTION 220000: GENERAL PROVISIONS - PLUMBING/FIRE PROTECTION

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary and other Conditions, if any) and all other applicable Divisions, apply to work of this Section.

B. This specification or drawing and the design features or resulting construction disclosed, are the property of Furlow Associates, Inc., and shall not be reproduced without written permission.

C. All fire protection suppression systems shall be part of and included in all of the following 220000 thru 220191 Sections.

1.2 WORK INCLUDED

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

1.3 REGULATIONS, CODES AND STANDARDS

A. Work shall be performed in accordance with latest adopted codes, regulations and ordinances by authorities having jurisdiction. Observe all safety regulations.

B. Latest editions of any referenced standards shall govern.

C. Obtain all municipal and/or the Authorities Having Jurisdiction permits and inspection certificates and pay all charges.

D. Make or arrange for any/or all inspection agency reviews or visits and pay all charges. This includes communication with each respective agency and/or utility to verify the project system work, coordination responsibilities, fees, back charges, etc., required.

E. All fees and back charges shall be verified during the bidding phase of the work. Any discrepancy of this item between any utility, inspection agency and the Contractor shall be brought to the attention of the A/E prior to bid opening.

F. Submission of a bid will be deemed evidence of having complied with these requirements.

1.4 RELATED WORK

A. Refer to equipment shown or specified in all other applicable Divisions that require Plumbing and Fire Protection services.

B. Refer to work related to Plumbing and Fire Protection as shown on the following contract drawings:

Architectural & Structural
HVAC
Electrical

1.5 COORDINATION

A. The Mechanical, Plumbing and Electrical Contractors are responsible to coordinate all manufacturer's recommended circuit breakers, starters, disconnects and fuse sizes for all equipment. Submission of a shop drawing will certify that this has been completed. Any necessary changes required will be included as part of this contract.

B. Plumbing and Sprinkler Contractors shall coordinate scheduling, submittals and work of the various sections of the Project Manual to ensure efficient and orderly sequence of installation of independent work elements, with provisions to accommodate items that may be installed at a later time.

C. Plumbing and Sprinkler Contractors shall verify utility requirements and all characteristics of operating equipment are compatible with the building utilities. Coordinate the work of all sections related and required for installing, connection and placing in service of all equipment.

D. Plumbing and Sprinkler Contractors shall coordinate all space requirements, supports and installation of all mechanical, electrical, plumbing and fire protection work, which are indicated diagrammatically on the Drawings. Verify routing of all pipes, ducts, conduits and equipment connections. Maximize accessibility for other work, and service requirements for maintenance and repairs. 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

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

H. Support vertical piping at floor levels using approved riser clamps. Clamp material shall be compatible with pipe material. Maximum vertical spacing shall 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. Sleeves, openings and sealants shall comply with applicable codes, recommended practices and standards, and manufacturer's instructions. Fire sealants shall have ability to prevent spread of flame, smoke or water throughout the penetration and shall pass 3 hour test, UL test ASTM E814 and UL 1479.

2. Products: Chase Corporation CTC PR-855, O. Z. Gedney CRS/CAFS, 3M Electro-Products Division Putty 303 or Caulk CP25 penetration sealing kits, General Electric Company sealants type RTV-850, 6428 or 7403, Thunderline Corporation "Link-Seal Pyro-Pak". Installation and type of sealant to be used as recommended by the manufacturer.

3. Expansion collars, fire seal/firestop collars – ASTM E814 (UL1479). Spec Seal Corporation, Inc. (plastic pipe).

3.9 PLATES

A. Furnish and install chrome plated plates wherever piping passes into finished area.

B. Plates shall be securely fastened to piping or building construction.

C. Floor plates shall cover 1 inch sleeve extension.

3.10 OFFSETS, TRANSITIONS, MODIFICATIONS

A. Furnish and install all offsets necessary to install the work and to provide clearance for other trades.

B. Maintain adequate headroom and clearance.

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

3.11 RECESSES

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

B. Make offsets or modifications as required to suit final locations.

3.12 LABELING

A. All Plumbing equipment such as pumps, and devices requiring identification for operating procedures shall be provided with permanent black laminated micarta white core labels with 3/8 inch letters.

B. This shall also apply to all controllers, remote start/stop pushbuttons and equipment cabinets.

3.13 FLASHING AND COUNTERFLASHING

A. Roof drains, vents, roof curbs, etc., shall have counterflashing fittings. General Contractor shall provide flashing.

B. Piping and conduit thru the roof shall be flashed by the General Contractor. Furnish and install counterflashing.

3.14 ACCESS

A. Locate all equipment, valves, devices and controllers which may need service in accessible places.

B. Where access is not available, access panels shall be provided. Furnish access doors to the General Contractor for installation.

C. Access doors shall be Elmdor, Karp Co., MIFAB or Controlled Air Manufacturing Limited, with 16 gauge frames and 14 gauge steel door, prime painted.

D. Maintain required access clearances.

3.15 WIRING

A. Packaged plumbing system equipment shall be furnished with disconnect switches, and magnetic starters, factory furnished and wired by the unit manufacturer.

B. All control wiring shall be furnished and installed under this Division of the work.

C. All wiring shall be in accordance with the National Electrical Code and as recommended by the equipment manufacturer.

3.16 UTILITIES

A. Do not interrupt any utility or service to the Owner without adequate previous notice and schedule.

B. Arrange and pay for the relocation, disconnection or removal of, or relocate, disconnect or remove existing utilities and services where such work is shown or where such utilities or services interfere with new construction, whether or not shown. Provide all excavation, backfilling and paving required by such work.

C. Perform alteration of utilities and services in accordance with the rules, regulations and requirements of the involved utility companies, regulatory agencies having jurisdiction.

3.17 CUTTING AND PATCHING EXTERIOR SURFACES

A. This Contractor shall be responsible for returning disturbed paved and/or grass areas to original condition where excavation for utilities has been required.

B. Cut and patch paved areas to match original surface.

C. Properly tamp backfill before finishing or repairing disturbed area surfaces.

3.18 OPENINGS - CUTTING, REPAIRING

A. This contractor shall cooperate with the work to be done under other sections in providing information as to openings required in walls, slabs and footings for all piping and equipment, including sleeves where required.

B. Any drilling or cutting required for the performance of work under this Section, shall be the responsibility of this Contractor and the cost thereof shall be borne by him.

C. Holes in Concrete: Sleeves shall be furnished, accurately located and installed in forms before pouring of concrete. This contractor shall pay all additional costs for cutting of holes as the result of the incorrect location of sleeves. All holes through existing concrete shall be either core drill or saw cut. All holes required shall have the approval of the Structural Engineer prior to cutting or drilling.

D. It shall be the responsibility of this Contractor to ascertain that all chases and openings are properly located.

3.19 GUARANTEE

A. All materials and equipment provided and/or installed under this section of the specifications shall be guaranteed for a period of one year 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 220000

SECTION 220010: 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

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

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. Fittings shall be rated 0□ to 250□ 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 Press-fit installation shall only be permitted on this project. Push-on shark-teeth, or any type connection fittings that are not Press-Fit, shall NOT be approved.

H. T-drill mechanically formed tee fittings shall be used in conjunction with the 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 220010

SECTION 220030: 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 (where noted)	½”	½”	¾”

END OF SECTION 220030

SECTION 220110: 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.

3. PVC pipe and fittings type DWV with solvent cement joint connections. (Not permitted in areas of plenum rated ceilings.)

2.3 CONDENSATE WASTE PIPING SYSTEM

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

1. PVC pipe and fittings type DWV with solvent cement joint connections. (Not permitted in areas of plenum rated ceilings.)

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

2.4 FLASHING

A. All vents extending through the roof shall be flashed by the General Contractor. However, the Plumbing Contractor shall furnish and install the necessary counterflashing consisting of a Jay R. Smith Figure 1748 counterflashing fitting, or approved substitute as manufactured by Josam or Zurn. Vents shall terminate 18" above the roof.

2.5 SPECIAL EXPANSION COMPENSATION

A. Special expansion compensation products required for storm, condensate, soil and waste piping systems include the following types:

B. Cast Iron Drainage System Expansion Joints: Cast-iron body, adjustable bronze sleeve, bronze bolts with wing nuts; for vertical installation only.

C. PVC Drainage System Expansion Joints: Factory prelubricated "O" ring expansion joint fitting. Installation must be in strict conformance with manufacturer's recommendations.

D. Available Manufacturers: Subject to compliance with requirements. Manufacturers offering expansion joints which may be incorporated in the work include:

1. Cast Iron Piping Systems - J.R. Smith or approved substitute.
2. PVC Piping Systems – George Fisher or approved substitute.

2.6 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. Floodgate / Backwater Valve Basin

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.

2.7 SYSTEMS EQUIPMENT

A. Refer to Plumbing Fixture and Equipment Schedule for type, number, size and manufacturer of all drainage equipment and accessories.

B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering drainage equipment which may be incorporated in the work are limited to the following:

Floor Drains (all types)

Zurn
Josam
Wade
Watts
Smith
MIFAB

Roof Drains

Zurn
Josam
Wade
Watts
Smith
MIFAB

Cleanouts

Zurn
Josam
Wade
Watts
Smith
MIFAB

Downspout Shoes

Neenah
Zurn
Josam
Wade
Smith
Watts
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 Nozzles

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 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.

3.4 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.

3.5 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.

3.6 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.

3.7 INSTALLATION OF DOWNSPOUT SHOES

A. Install downspout shoes in accordance with manufacturer's written instructions and in locations indicated.

B. Downspout shoes shall be installed with top of shoe located 18 inches above finished grade.

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 220110

SECTION 220120: 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. Refer to Section 220005 for a general description of the scope of work in this contract.

B. This Section includes:

1. Domestic water piping systems work is indicated on drawings and schedules and by requirements of this section.

C. 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 Mechanical/Boiler Room.

4. Exterior fire/sprinkler service from street main connection to flanged connection 12" above finished floor slab in Mechanical/Boiler Room.

5. Exterior domestic water meter and pit installation.

6. Domestic cold-water piping.

7. Domestic hot-water piping.

8. Domestic recirculating-water piping.

D. Complete flow balancing of the entire domestic hot water return system.

E. Insulation for domestic water piping as specified in Section 220030 is included as work of this section.

F. 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. Sectional Valves:

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

C. Shutoff Valves:

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

D. Drain Valves:

All	Hose End Threaded Gate or Ball Valves.

E. Balancing Valves:

2" and Smaller:	Ball Valves (Circuit Setter Type). (w/ Memory Stop)

F. Check Valves:

All Sizes:	Swing Check Valves. Horizontal Installations Spring Check Valves. Vertical Installations

2.6 WATER METER

A. Provide water meter and related piping conforming to applicable local Utility Company regulations and AWWA Standards.

B. Water Meter: Provided by Local Utility Company. Provide roughing- in and bypass for meter in accordance with Utility Company requirements.

2.7 SPECIAL VALVES

A. Special valves required for domestic water piping systems include the following types:

B. Hose Bibbs: Threaded end, renewable composition disc, tee handle, 3/4" NPT inlet, 3/4" hose outlet with vacuum breaker.

1. Finished Areas: Chrome plated.
2. Unfinished Areas: Bronze finish.

C. Wall Hydrants: Non-freeze, cast-bronze body, tee handle key, bronze casing, length to suit wall thickness, vacuum breaker, hinged locking cover, 3/4" inlet, hose outlet.

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>Automatic Trap Primers</u>
PPP Inc.
Sloan
Sioux Chief
MIFAB

<u>Hose Bibbs</u>
Nibco
Tanner
Central Brass
Wolverine

<u>Wall Hydrants</u>
Nibco
Tanner
Central Brass
Wolverine

<u>Wall Hydrants</u>
Zurn
Josam
Wade
Watts
Smith

Woodford
MIFAB

Lawn Boxes
Zurn
Josam
Wade
Watts
Smith
Woodford
MIFAB

Backflow Preventers
Conbraco
Febco
Cla-Val
Wilkins
ITT Grinnell
Neptune
Watts

Relief Valves
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 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 Water Department.

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 AUTOMATIC TRAP PRIMERS

A. Install units in accordance with manufacturer's written instructions.

B. Cap-off all unused tube connections not to be used for discharge procedures.

C. Units installed in Mechanical Room shall be surface mounted. All others shall be arranged for recessed installation and shall include a 14"x16" access door #D-1416SS.

D. All discharge tubing from the tube connectors to the floor drain connection shall be minimum Type "M" copper for above floor slab installations. Where discharge piping runs below the floor slab, the piping may be PVC grade water piping. Ensure that all connections are properly made and leak-free.

E. Verify all electrical connections prior to the start-up of the units.

F. Shield copper from direct contact with concrete, stone and sharp edges below slab.

3.15 SPARE PARTS

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

3.16 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.

3.17 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.

3.18 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 220120

SECTION 220130: 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. Refer to Section 220005 for a general description of the scope of work in this contract.

B. This Section includes:

1. Natural gas piping system as indicated on drawings and schedules, and by requirements of this section.

2. Applications for natural gas piping systems include the following:

a. Gas service from main to building meter by Delmarva Gas Division.
b. Elevated pressure (psi) gas from meter location to rooftop gas-fired equipment and to all other equipment and outlets, requiring gas service.

3. Trenching and backfill required in conjunction with exterior gas distribution as specified in Section 220000 is included as work of this section. Refer to Division 1.

1.3 REFERENCE STANDARDS

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

1.4 QUALITY ASSURANCE

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

1.5 SUBMITTALS

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

B. Submit the following:

1. Product data on gas valves.

1.6 WARRANTY/GUARANTEE

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

PART 2 – PRODUCTS

2.1 NATURAL GAS PIPING MATERIALS AND PRODUCTS

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

2.2 BASIC IDENTIFICATION

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

Building Distribution Piping: Plastic pipe markers.

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

Gas Valves: Plastic valve tags.

2.3 BASIC PIPE, TUBE AND FITTINGS

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

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

   Fittings: Malleable black iron, threaded (NCC)

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

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.

Gas Valves (4" and Larger)

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

   Standards of Compliance:
   IFGC: Section 409 (Valves)
   ASME B16.5 – Pipe Fittings and Flanges
   ASME B16.33 – Manual Operated Metal Gas Valves up to 125 psig
   ASME B16.38 – Large Metal Valve Gas Distribution
   ASME B31.8 – Gas Transmission and Distribution Piping Systems
   UL 125

B. Manufacturers: Subject to compliance with requirements, provide gas valves of one of the following:

Apollo/Conbraco
Stockham
Milwaukee
NIBCO, Inc.
Watts

2.6 GAS METER

A. Provided by Delmarva 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.

3.3 GAS SERVICE

A. Arrange and coordinate with Utility Company to provide gas service and meter at indicated location with shutoff at terminus. Consult with Utility as to extent of its work, costs, fees and permits involved. Pay such costs and fees; obtain permits.

B. Extend service pipe from Utility's terminus to distribution piping, in compliance with Utility's requirements.

3.4 INSTALLATION OF VALVES

A. Gas valves: Provide at connection to gas train for each gas-fired equipment item; and on risers and branches where indicated.

B. Locate gas valves where easily accessible, and where protected from possible damage.

3.5 EQUIPMENT CONNECTIONS

A. Connect gas piping to each gas-fired equipment item, with drip leg, union and shutoff gas valve. Comply with equipment manufacturer's instructions. Drip legs shall not be installed on any exterior gas piping.

B. Equipment furnished by the Owner, or Contractors other than this Contractor: After equipment has been set in place, this Contractor shall furnish all labor and material required to make final connections between roughing-in and the equipment. Install valves, fittings, trim and appurtenances furnished with the equipment. Piping shall be of the same material as the system to which it connects.

C. All rooftop, gas-fired equipment shall be provided with gas pressure regulating valve to reduce gas pressure from 2 psi to 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 220130

SECTION 220140: 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. Refer to Section 220005 for a general description of the scope of work in this contract.

B. 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:

<u>Water Closets (Wall-Mounted Back Outlet – China)</u>
Crane
American Standard
Kohler
Toto

<u>China/Enameled Fixtures</u>
Kohler
American Standard
Eljer
Crane
ToTo

<u>Wash Fountains</u>
Acron with metered faucets (only)

<u>Faucets/Trim (Non-Sensor Operated)</u>
Kohler
American Standard
Delta
Moen
Elkay
Speakman
Chicago

<u>Flush Valves</u>
Sloan “Royal”
Coyne & Delany
Zurn
ToTo

<u>Wall Supplies/Traps</u>
McGuire
Brass-Craft
Kohler
American Standard
Sanitary-Dash
Teledyne
Wolverine
Pro-Flo
Keeny

<u>Fixture Carriers</u>
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

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

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
Kohler
American Standard
Acryline
Aqua-Glass
Aquarius
Aqua-Bath

Washer Utility Boxes
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 <u>all</u> 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 220140

SECTION 220150: 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. Refer to Section 220005 for a general description of the scope of work in this contract.

B. 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
Solids Interceptor
Domestic Water Heaters
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 as indicated on the drawing.

B. Pumps shall be close coupled, centrifugal type, all low lead or lead-free bronze with flexible connection to a 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. The water heater shall be Bradford White Model D-80T-505-3N(A) with a storage capacity of not less than 80 gallons, a minimum input of 505,000 BtuH, and a minimum recovery of 489 GPH at 100 deg. F. 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. The in-ground grease interceptor shall be constructed 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 duty. The interceptor shall be of the minimum size of 1,000 gals and provided with all equipment and accessories necessary for in-ground installation.

2.6 SOLIDS INTERCEPTOR

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

2.7 MANUFACTURERS

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

1. Domestic Water Heaters
   Ruud
   Bradford-White
   State

2. Hot Water Circulating Pumps
   Armstrong
   Bell and Gossett
   Taco
   Aurora
   Grundfos
   Amtrol

3. Solids Interceptors
   Zurn
   Josam
   Wade
   Ancon
   Smith

4. Exterior Interceptor
   Highland Tank
   Tyson F. Sartin
   A.C. Miller
   Penn Cast

5. Master Mixing Valve (Domestic Hot Water System)
   Holby Valve Co.
   Acorn

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

A. Provide pump and control systems capable of pumping water while containing oil. The system shall function automatically and shall provide for an alarm and separate LED lights in the event of (a) the presence of oil in the sump, (b) high liquid in the sump, or (c) high amps or a locked rotor condition. In addition, LED lights shall be provided for (1) power and (2) pump run function. An alarm that sounds only in the event of a high liquid condition or does not separately identify the above five functions shall not be acceptable.

B. The pump shall be a submersible type, capable of pumping up to 37' TDH and 74 GPM. The pump shall be approved to UL 778 standards and shall include thermal and overload protection. The motor shall be rated 1/2 H.P., 1 phase, 115V and capable of operating continuously or intermittently. The motor housing shall be constructed of #304 stainless steel and mechanical seats shall be housed in a separate oil-filled compartment.

C. The main control shall be approved to UL 508 standards and housed in a gasketed NEMA 4X enclosure with a see-through window for observation of operating functions. The control unit, junction box, pump, floats and sensor shall be factory assembled as a complete, ready-to-use system and shall be tested and approved as a complete system by a nationally recognized testing laboratory such as ENTELA. The control panel shall be equipped with dual solid state Oil-Minder relays with variable sensitivity settings, an over current relay, self-cleaning stainless steel sensor probe, high decibel warning horn with alarm silencing switch, dual floats, clearly marked cable terminal board and remote monitoring contact. A NEMA 4X (sump pit) junction box with rigid conduit shall be provided. (Note: The control panel and the NEMA 4X (sump pit) junction box shall not be provided with 8-pin twist lock receptacles. All pump power and control cables between the control panel and NEMA 4x junction box shall be by the E.C. and shall have their length determined in the field. The cables between the control panel and junction box shall be connected directly to the equipment terminal boards and shall be run in ridge, galvanized conduit.) See installation detail on Plumbing Drawings. All cables between the pump and junction box shall be 16 ft. long and the power cable and plug from the control panel shall be 6 ft. long. The system shall allow for the main control to be located outside of the elevator hoistway and monitoring of all functions without having to enter the elevator shaft.

PART 3 – EXECUTION

3.1 INSTALLATION OF WATER HEATERS

A. Install water heaters where indicated in accordance with manufacturer's installation instructions and in compliance with applicable codes.

B. Set units where indicated, orient so controls and devices needing service and maintenance have adequate access. Level and plumb units. Each unit shall be set on a concrete housekeeping pad.

C. Existing Mechanical Room: Reconnect existing gas hot and cold piping to new unit. Alter piping to suit new connections. Connect recirculating line to unit with check valve and shutoff valve. Extend relief valve discharge to nearest floor drain. Extend and connect new flue exhaust to existing breeching.

D. New Mechanical Room: Connect gas, hot and cold and recirculating piping system and all associated equipment and devices as detailed on the drawing. Flue extension, roof penetration and weatherproof hood shall be by this Contractor.

E. Start-up, test and adjust hot water heaters in accordance with manufacturer's start-up instructions. Check and calibrate controls.

3.2 INSTALLATION OF THERMOSTATIC MIXING VALVE

A. Install mixing valve in accordance with manufacturer's installation instructions and in compliance with applicable codes.

B. At startup of domestic hot water system, mixing valve outlet temperature shall be checked to insure

proper setting and operation. Following adjustments, if required, the mixing valve, if not performing. check if factory required differential temperature in/out with a minimum of 20º Delta “T” is maintained.

C. Provide minimum 27" (end of pipe to end of pipe) heat trap in accordance with manufacturer's recommendations and as detailed on the drawing.

D. 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.

E. Check valves shall be installed on both inlet (hot and cold) to the unit. Include a full-size bypass valve arrangement.

F. 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 220150

SECTION 220190: 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

C. 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.

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.

<u>Warning: PVC and CPVC Pipe:</u> 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 220190

SECTION 220191: 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 220191

SECTION 230200: GENERAL PROVISIONS – HVAC

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

B. This specification or drawing and the design features or resulting construction disclosed, are the property of Furlow Associates, Inc., and shall not be reproduced without written permission.

C. All Mechanical Systems shall be part of and included in all of the following: 230200 thru 230950.

1.2 WORK INCLUDED

A. Provide labor, materials, equipment and supervision necessary to install complete operating HVAC Systems, including all work at the site and within the proposed construction areas to accomplish the required work.

B. Wherever the term "provide" is used, it shall be understood to mean both "furnish" and "install".

1.3 REGULATIONS, CODES AND STANDARDS

A. Work shall be performed in accordance with latest adopted codes, regulations and ordinances by authorities having jurisdiction. Observe all safety regulations.

B. Obtain all permits and inspection certificates and pay all charges.

C. Latest editions of any referenced standards shall govern.

1.4 RELATED WORK

A. Refer to equipment shown or specified in sections of Division 1 thru 14 and 26 that will require Mechanical services and provide such service.

B. Refer to work related to HVAC as shown on the following contract drawings:

Architectural & Structural
Plumbing
Electrical

C. This Contractor shall coordinate with the work of Division 26 and the Fire Alarm System vendor for locations and mounting of all duct smoke detectors. These devices are shown on the Mechanical Drawings for reference only to show the intent of the work. All locations shall be determined based on approved shop drawings from the Fire Alarm System vendor and the Contractor for the work of Division 26, Electrical.

1.5 COORDINATION

A. The Mechanical, Plumbing and Electrical Contractors are responsible to coordinate all manufacturer's recommended circuit breakers, starters, disconnects and fuse sizes for all equipment. Submission of a shop drawing will certify that this has been completed. Any necessary changes required will be included as part of this contract.

B. Mechanical Contractor shall coordinate scheduling, submittals and work of the various sections of the Project Manual to ensure efficient and orderly sequence of installation of independent work elements, with provisions to accommodate items that may be installed at a later time.

C. Mechanical Contractor shall verify utility requirements and all characteristics of operating equipment are compatible with the building utilities. Coordinate the work of all sections related and required for installing, connection and placing in service of all equipment.

D. Mechanical Contractor shall coordinate all space requirements, supports and installation of all mechanical, electrical, plumbing and fire protection work, which are indicated diagrammatically on the Drawings. Verify routing of all pipes, ducts, conduits and equipment connections. Maximize accessibility for other work, and service requirements for maintenance and repairs. Develop overall coordination drawing (all trades) and submit for review prior to fabrication/installation.

E. Obtain written confirmation from all related trade Contractors and the Owner or his representative that requirements, conflicts and coordination issues have been discussed and resolved.

F. Submit coordination drawings to verify access and clearances.

1.6 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations..

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installation within unheated shelters.

1.7 SUBMITTALS

A. Shop Drawings:

1. Shop drawings shall be submitted in accordance with Division 1 of these specifications except where herein modified.

2. Shop drawings comprising complete catalog cuts, performance test data for HVAC equipment as required by other sections of Division 23, shall be submitted for review checking. The Contractor shall review these shop drawings for conformance to contract documents prior to submission and affix contractor's signature to each submittal certifying that this review has been done. By approving and submitting shop drawings, product data, samples and similar materials, the Contractor represents that the Contractor has determined and verified materials, field measurements and field construction data that relates to the work, and has checked and coordinated this information with all of the requirements contained in the contract documents for the work of all trades.

a. The Contractor and equipment manufacturer shall clearly 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.

3.5 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.

3.6 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 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, Thunderline Corporation "Link-Seal Pyro-Pak". Installation and type of sealant to be used as recommended by the manufacturer.

3.7 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.

3.8 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.

3.9 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.

3.10 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. Refrigeration Machinery Rooms shall be identified with a permanent placard of red-white-red laminated, commercial grade, plastic construction. Letters shall be minimum one inch high for the header to read in capital letters: WARNING – REFRIGERATION EQUIPMENT ROOM – LIMITED ACCESS. The following information shall be posted in a similar fashion, minimum half-inch high capital letters, indicating:

1. The name and address of the installer.
2. The refrigerant number and amount of refrigerant in pounds.
3. The lubricant identity and amount in pounds or ounces as appropriate.
4. The field test pressure applied to the equipment in psig.

Placard shall be centered on each door leading into the refrigeration equipment room at five feet above the floor and attached at each corner with brass screws.

F. 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.

3.11 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.

3.12 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.

3.13 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.

3.14 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.

3.15 PAINTING

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

3.16 GUARANTEE

A. All work shall be guaranteed to be free from defects for a period of one year 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 one year 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.

3.17 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.

3.18 TESTING AND BALANCING OF MECHANICAL EQUIPMENT

A. Perform field mechanical balancing in accordance with Section 230950: 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 230200

SECTION 230210: 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)

NOTE: VICTAULIC PIPE SHALL BE ALLOWED IN THE BOILER ROOM PIPING AND BETWEEN THE CHILLER AND COOLING TOWER.

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
Condenser Water-30 deg. to 150 deg. F
Dual Temperature Water – 30 deg. to 240 deg. F.

C. Manufacturer: U.S. Gauge, H.O. Trerice, Moeller, Duro, Miljoco Corp., Winter Instruments.

2.6 GAUGES

A. Phosphor bronze bourdon tube, polypropylene case, gasketed glass crystal, aluminum dial, black graduations 4-1/2 inch diameter.

B. Range: 0 to 60 psi, 5 pound intervals, 1/2 pound graduations.

C. Install with bronze gauge cock.

D. Manufacturers: Danton, U.S. Gauge, H.O. Trerice, Moeller, Miljoco Corp., Winter Instruments, Weksler Instruments.

2.7 TEST STATIONS – PRESSURE/TEMPERATURE

A. Provide a SISCO 1/4" or 1/2" NPT fitting (Test Plug) of solid brass at desired indicated locations. Test plug shall be capable of receiving either a pressure or temperature probe 1/8" o.d. Dual seal core shall be neoprene for temperature to 200 degrees F. Nordel to 350 degrees F and shall be rated zero leakage from vacuum to 1000 psig. P/T plug to have grooved cap and chain.

B. P/T plugs shall be provided with extensions as required by insulation.

C. Mechanical Contractor shall also provide the following: pressure gauge adapters with 1/8" o.d. probe, 5" stem pocket testing thermometers for 25° to 125° F (tower and chilled water) for 0° to 220° F (hot water) for 50° - 500° F (temperatures above 220° F).

D. One (1) Master Test Kit shall be furnished to the Owners. Kit shall contain one (1) 2-1/2" test gauge of suitable range, one (1) Gauge Adapter 1/8" o.d. probe, and 5" stem pocket testing thermometers - one (1) 0° - 220° F and one (1) 50° - 550° F.

E. Manufacturer: Sisco P/T Plugs.

2.8 ISOLATING FITTINGS

A. Provide isolating fittings between all sections of dissimilar piping materials or piping and equipment where one material is ferrous and the other is non-ferrous.

B. Manufacturer: Epco Sales, Inc., or insulated unions by Central Plastic Co.

2.9 PIPE SADDLES

A. Steel pipe saddles shall be welded to all black ferrous pipe, 2-1/2" pipe size and larger, at hanger locations, for systems of hot water and other heat conveying systems.

B. Steel pipe saddles shall be welded to all black ferrous hot piping at the pipe support location when roll type hangers or pipe roll supports are employed.

C. The saddles shall be packed with plastic insulating cement, and the saddle shall finish flush with the surface of the specified insulation.

2.10 ANCHORS AND GUIDES

A. Anchors and guides shall be provided to support and maintain pipes in position and properly distribute expansion. The anchors and guides must be securely fastened to the building structure, and must be completely installed before the system is tested.

B. Factory made cast semi-steel or fabricated steel, consisting of a bolted two-section outer cylinder and base with two-section guiding spider bolted or welded tight to the pipe.

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**

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
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.

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 loops 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 chiller and cooling tower.)

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 chiller and cooling tower.)

3. Condenser Water Supply & Return Piping:

   a. Schedule 40 black steel.
   b. Grooved End black steel (Only permitted in Boiler Room and between chiller and cooling tower.)

4. Make-up Water: Type L hard copper.

5. 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 chiller and cooling tower.)

6. AC Condensate Drain (including pumped condensate):

   a. Type DWV copper.

7. 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.	Cooling Tower Water Supply	- Green	- White
4.	Cooling Tower Water Return	- Green	- White
5.	Gas	- Yellow	- Black
6.	Heating Water Supply	- Yellow	- Black
7.	Heating Water Return	- Yellow	- Black
8.	Dual Temperature Water Supply	- Yellow	- Black
9.	Dual Temperature Water Return	- Yellow	- Black
10.	Refrigerant Liquid	- Yellow	- Black
11.	Refrigerant Gas	- Yellow	- Black
12.	Cold Water Make-up	- Green	- White
13.	Vent	- Yellow	- Black

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

Condenser Water: - Green
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
6. Condenser water 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 230210

SECTION 230215: 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. Condenser Water and 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 CONDENSER WATER AND 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 (Teflon Disc)	Stockham B-14T (Teflon Disc)
Stockham B-16 (Bronze Disc)	Stockham B-17 (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. Butterfly Valves - 2-1/2" and Larger: (Condenser Water)

Ditto Chilled Water except with aluminum bronze discs.

Stockham LD-712-BS3-E Lever Operated
Stockham LD-722-BS3-E Gear Operated
Victaulic 300 Masterseal and AGS VIC300-grooved-end

Lever:	Gear:
Demco NE-150-5214351	NE-150-5214359-2098
Norris R3010-43SS-1F	R3010-43SS-2K
Keystone 129	129
Center Line series LT	Series LT
Grinnell LC8201-1	LC8202-13

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

H. 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.

I. 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 230215

SECTION 230230: INSULATION & COVERING – HVAC

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

B. Refer to Section 230200 for HVAC General Provisions

C. Refer to Section 230210 for HVAC Basic Materials & Methods.

1.2 DESCRIPTION OF WORK

A. This Section includes insulation and covering provided on the following piping and equipment:

1. Cold Water Make-Up Piping
2. Hot Water Heating Piping
3. Chilled Water Piping
4. Condensate Drain Lines
5. Dual temperature water piping.
6. Refrigerant Piping.
7. Cold Equipment Surface
8. Hot equipment surfaces.
9. 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 230200 for a general description of requirements applying to this section.

1.4 QUALITY ASSURANCE

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

B. Install insulation in accordance with manufacturer's recommendations.

C. Provide adequate supervision of labor force to assure that all aspects of the specifications are being fulfilled.

1.5 SUBMITTALS

A. Submit shop drawings, installation instructions, and manufacturer's literature of all materials specified in accordance with Section 230200.

B. Submit fabrication instructions for pipe fitting and valve insulation.

C. Submit manufacturer's joining recommendations for butt joints and longitudinal seams.

1.6 WARRANTY/GUARANTEE

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

PART 2 – PRODUCTS

2.1 PIPE INSULATION MATERIAL

A. Fiberglass:

1. Material: Preformed fiberglass bonded with resin to form circular pipe sleeves with factory applied, white all service jacket bonded to reinforced foil vapor barrier jacketing. The jacket shall have factory applied double pressure-sensitive, self-sealing, adhesive closure and vapor sealing of longitudinal joints. Thermal conductivity: 0.24 Btu/Hr./SF/inch at 100 degrees F. Flame spread of 25 and developed smoke of 50 or less.

2. All Valves and Fittings:

a. Glass fiber insert and pre-molded PVC cover, Johns Manville Corp. "Zeston" and "Hi-Lo Temp Inserts" for fittings. Glass fiber or prefabricated elastomeric foam fittings must fill the entire space within the cover completely.

b. Factory molded fibrous glass fitting covering for fittings. Coat ends with Fosters 30-36 lagfast adhesive

c. Mitered sections of pipe covering for valves.

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

B. Closed Cell:

1. Material: Black flexible elastomeric foamed closed cell structure insulation 25/50 rated with a flame spread rating of 25 or less and a smoke developed rating of 50 or less with both a moisture seal and a reinforced elastic foam lap seal closure system.

2. Flexible pipe insulation shall be a foamed elastomeric closed cell structure material, with a thermal conductivity of not more than 0.27 Btu/Hr./Sq. Ft./Inch at a mean temperature of 75 degrees F. The insulation shall have an average density of at least 2 pounds per cubic foot, shall be self-extinguishing, and shall have a water vapor transmission rating of not more than 0.1 perms. Between temperature limits of -40 degrees F and plus 220 degrees F, the insulation shall not indicate any deviation from its original state.

3. Specification Compliance:

ASTM-E-84
ASTM-C-534 Type I – Tubular, Type II – Sheet.
ASTM-D-1056, 2B1 – Tubular, Sheet.
MIL-C-3133B (MIL STD 670B) Grade SBE-3
MIL-P-15S280J, Form T, Form S.

4. Manufacturers: Armacell, Nomaco, K-Flex, Rubatex.

C. Covering of Pipe Insulation Outdoors:

1. Wrapping: Wrap insulation with embossed 0.016" aluminum jacket.

2. Fastenings: Cover shall be held in place with soft aluminum bands on 12" centers.
3. Valves and Fittings: Weatherproof all valves and fittings.

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

2.2 DUCT INSULATION

A. Concealed Supply, Return, Relief, and Outside Air Ductwork, and all ductwork connected to energy recovery units: Fiberglass duct wrap bonded with resins, 3/4 pound density, aluminum foil facing reinforced with fiberglass scrim, laminated to Kraft, 2" thick.

1. Thermal Conductivity: 0.27 Btu/Hr./SF/Inch at 75 degrees F. Min. installed "R" value w/25% compression shall be 5.6.

2. Duct wrap shall be cut to stretch-out dimensions as provided in manufacturer's instructions. Remove a 2" piece of insulation from the facing at the end of the piece of insulation to form an overlapping staple and tape flap. Install with facing outside so tape flap overlaps insulation and facing at other end. Insulation shall be tightly butted and not compressed excessively at duct corners. Seams shall be stapled 6" on center with outward clinching staples. All seams, tears, punctures and other penetrations of the insulation facing shall be sealed with foil tape or vapor proof mastic. Where rectangular ducts are 24" in width or greater, duct wrap shall be secured to the bottom of the duct with mechanical fasteners; i.e., stick pins spaced 18" on center.

B. Exposed supply, return, relief, and outside air ductwork, and all ductwork connected to energy recovery units, shall be insulated in finished conditioned spaces, penthouse, mechanical rooms, mezzanine areas, equipment closets, and non-conditioned spaces with 2" thick rigid fiberglass board. Insulation shall be 6 P.C.F. density with a "K" value of 0.25 Btu/Hr./SF/Inch at 75 degrees F. mean temperature and shall be U.L. listed at 25 maximum for flame spread, and 50 maximum for smoke developed. Insulation shall be applied using Graham Pins or Stik-Clips and all seams, edges and breaks shall be sealed with 4" matching tape and sealed with Vicryl CP-10 to match ASJ jacket. Insulation shall be provided with all-service jacket facing.

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

D. Outdoor Installation:

1. Pre-manufacturer panel system consisting of four (4) piece, interlocking panels.

2. The interlocking panels shall be constructed of Dow Thermax Polyisocyanurate insulation, ASTM D-1622, nomina 2 pcf; water vapor tramission as permeance less than 0.03, per ASTM E-96; water absorption less than 0.3% (24 hours), per ASTM C-209; flexure strngeth 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.

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. Plumbing: Cold water make-up to cooling tower.
   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 230230

SECTION 230300: 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. Cooling towers
7. 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 insure 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. Cooling Towers or Closed-Circuit Cooler:

1. Provide hot dip galvanized (if outdoor installation) adjustable, open-spring isolators having coil springs attached to the top compression plate and baseplate. An elastomeric pad having a minimum thickness of 1/4" shall be bonded to the baseplate. Nuts, adjusting bolts, and washers shall be zinc-electroplated.

2. The spring assembly shall be removable and shall fit within a welded steel enclosure consisting of a top plate and rigid lower housing. Isolated restraining bolts shall connect the top plate and lower housing to prevent the equipment from rising when drained of water. Amber/Booth Type CT/CTC.

3. Provide a hot dipped galvanized structural steel base for increasing rigidity of equipment. The steel members shall have a minimum depth of 1/12 of the longest span, but not less than 6" deep.

4. Junior beams and junior channels shall not be used. Cross members shall be provided where necessary to support the equipment or to prevent twisting of the main members.

G. 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

H. 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 230300

SECTION 230400: 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.- Crest 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 oil fire and shall submit written report to the Owner.

7. The same factory mechanic shall make two more trips to the job within the succeeding eight months from the date of the above-mentioned letter for the purpose of further adjusting and checking and shall be immediately available in the event of operating failure of the units within a period of one year from the date of the letter.

E. Tools and spare Parts for Each Boiler: Furnish and obtain receipt for complete set of gaskets, flue brush and scraper with light weight handles and all special tools that may be required.

END OF SECTION 230400

SECTION 230410: HEATING GENERATION AUXILIARY EQUIPMENT

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

B. Refer to Section 230200 for HVAC General Provisions.

C. Refer to Section 230210 for HVAC Basic Materials and Methods.

D. Refer to Section 230400 for Heating Generation Equipment.

1.2 DESCRIPTION OF WORK

A. This Section includes labor, material, and equipment necessary for a complete boiler system as specified and shown on the drawings:

1. Gas Vent Pipe & Pipe Fittings
2. Miscellaneous Breeching Materials

B. Provision for boiler vent and combustion air piping.

C. Refer to other Division 23 sections for related work.

1.3 REFERENCE STANDARDS

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

1.4 QUALITY ASSURANCE

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

B. Quality Assurance:

1. Manufacturers: Firms regularly engaged in manufacture of equipment types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

2. Regulatory Requirements:

a. NFPA Compliance: Install gas-fired cast-iron boilers in accordance with National Fire Protection Association (NFPA) Code 54 "National Fuel Gas Code".

b. NFPA 211 Compliance: Heating equipment burning gas, solid or liquid fuels, Section 60.

1.5 SUBMITTALS

A. Submit shop drawings and product data in accordance with Section 230200.

B. Submit the following:

1. Shop Drawings
2. Product Data
3. Evidence of specified code or other compliance.

1.6 SUBSTITUTIONS

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

1.7 WARRANTY/GUARANTEE

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

PART 2 – PRODUCTS

2.1 GAS VENT PIPE & FITTINGS

A. The gas vent system shall be so engineered and constructed as to develop a positive flow adequate to exhaust all flue gases to outside atmosphere, without condensation within the vent.

B. All parts of vent system shall be of Underwriters' Laboratories, Inc., listed Metal-Fab Type CORR/Guard Model CG, double wall gas vent piping, and such piping shall be continuous from the appliance outlets into Metal-Fab vent terminal. Venting System shall be rated at 6” W.C. and tested to 15” W.C. per UL Standard 1738.

C. The Metal-Fab gas vent piping shall be installed in full compliance with the terms of its listing, with the manufacturer's installation instructions, and with nationally recognized building codes representing good practice for such installations.

D. For vent sizes 6” to 12” inside diameter, inner wall thickness shall be 0.015”, Type AL29-4C stainless steel.

Outer casing shall be 0.018”, aluminized steel.

E. Inner and outer walls shall be connected by means of spacer clips that maintain concentricity of the annular space and allow differential thermal expansion of the inner and outer walls.

F. All supports, wall penetration, terminal with miter cut and birdscreen, boiler connector and condensate drain fitting shall be included.

G. All joints shall be sealed using manufacturer’s approved sealant. Joints exposed to the weather shall be sealed to prevent rainwater from entering the annular space between inner and outer walls.

H. Provide adequate accessibility, head room and dimensions so that all vent connections can be correctly sized, spaced and supported.

I. Manufacturers: Metal-Fab, Metalbestos, Heat Fab, Inc., American Metal Products, Van-Packer Co.

2.2 MISCELLANEOUS BREECHING MATERIALS

A. Provide miscellaneous materials and products of types and sizes to comply with boiler requirements including proper connection of equipment.

B. Provide PVC combustion air intake pipe and accessories:

1. Pipe: ASTM D-1785 Schedule 40, Type 1, Grade 1.
2. Fittings: ASTM D-2466, Schedule 40.
3. Solvent Cement: ASTM D-2564, Schedule 40 and DWV.

4. Uniformity: To ensure installation uniformity, all piping components shall be of one manufacturer.
5. Flux shall be non-toxic type and non-corrosive.

PART 3 – EXECUTION

3.1 BOILER GAS VENT PIPE

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

3.2 GAS VENT PIPE (PRE-ENGINEERED)

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

END OF SECTION 230410

SECTION 230450: 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. Rotary Screw Water Chiller
2. Fluid Cooler (Closed-Circuit Type)
3. Ductless Split System Heat Pump Units
4. Refrigerant Gas Detection System

B. Provide complete refrigeration system including chillers, cooling towers, aboveground piping and all required accessories.

1.3 REFERENCE STANDARDS

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

B. Comply with applicable provisions of:

1. International Mechanical Code
2. ASME Codes for Pressure Vessels
3. A.R.I. Capacity Ratings
4. NFPA Pamphlets
5. ASHRAE Standard 15
6. ASHRAE Standard 90.1, Section 6, Table 6.8.1A thru J, minimum equipment efficiency.

1.4 QUALITY ASSURANCE

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

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

C. Verification of Fluid Cooler Performance:

1. Manufacturer shall have a thermal performance testing program for water cooling towers certified by the Cooling Technology Institute (CTI) in accordance with CTI Specification Standard STD-201. Manufacturer's performance guarantees or performance bonds shall also be accepted.

2. Unit Sound Performance ratings shall tested and certified according to CTI ATC-128 standard. Sound ratings shall not exceed specified ratings.

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, for five (5) years from start-up.

PART 2 – PRODUCTS

2.1 ROTARY SCREW WATER CHILLERS

A. General: The contractor shall provide rotary screw water chiller as shown and scheduled on the plans. The units shall be installed in accordance with this specification and produce the specified tonnage per the scheduled data in accordance with ARI Standard 550/590-98. The unit shall be ARI certified as applicable.

B. Included are:

1. Chiller package.
2. Charge of refrigerant and oil.
3. Controls and control connections.
4. Chilled water connections.
5. Condenser water connections.
6. Starters.
7. Electrical power connections.

C. References:

1. ANSI/ASHRAE STANDARD 15-1992 - Safety Code for Mechanical Refrigeration.
2. ANSI/ASME SEC VIII - Boiler and Pressure Vessel Code.
3. ANSI/ASME B31.S-1983 ASME Code for Pressure Piping and Refrigeration Piping.
4. ANSI/UL 1995 - Central Cooling Air Conditioners.
5. UL 984 - Safety Standards for Hermetic Motor Compressors.
6. ANSI/ARI 550/590-98 - Standard for Water Chilling Packages using the Vapor Compression Cycle.
7. ARI STANDARD 575-87 - Method of Measuring Machinery Sound Within Equipment Rooms.

D. Submittals

1. Submit drawings indicating components, assembly, dimensions, weights and loadings, required clearances, and location and size of field connections. Indicate equipment, piping and connections, valves, strainers, and thermostatic valves required for complete system.

2. Submit product data indicating rated capacities, weights, specialties and accessories, electrical requirements and wiring diagrams.

3. Submit manufacturer's installation instructions.

E. Operation and Maintenance Data

1. Include start-up instructions, operation data, maintenance data, controls, and accessories. Include trouble-shooting guide.

F. Verification of Capacity And Efficiency

1. All proposals for chiller performance must include an ARI approved selection method.

G. Regulatory Requirements

1. Conform to ARI Standard 550/590-98 for rating and certified testing of Water Chilling Packages using the Vapor Compression Cycle.

2. Conform to ANSI/UL 1995 - Standard for Heating and Cooling Equipment, Safety Standard

3. Conform to ASME SECTION VIII Boiler and Pressure Vessel Code for construction and testing of unfired pressure vessels.

4. Conform to ANSI/ASHRAE STANDARD 15-1992 safety code for mechanical refrigeration.

H. Handling

1. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

2. Protect units from physical damage. Leave factory shipping covers in place until installation.

I. Compressor and Motor

1. The compressor shall be rotary screw or centrifugal type. Compressor shall be semihermetic and utilize twin rotor design.

2. Chiller should be able to unload to 25 percent of full load tonnage with constant entering condenser water temperature.

3. The motor shall be semi-hermetic and either suction gas or liquid refrigerant cooled. Hot gas motor cooling is not acceptable. If an open motor design is used, the motor shall be a TEFC and the contractor shall provide and install a properly designed mechanical ventilation system to remove motor heat. The mechanical equipment room temperature is not to exceed 104 F in the space. Typical heat rejection on open motor designs is 10% of the total motor input KW. Manufacturer shall list, on its bid, additional KW requirement for ventilation system, additional maintenance requirements due to alignment, refrigerant seal, coupling and bearings.

4. Manufacturers with speed increasing transmissions that exceed 10,000 RPM compressor speeds shall annually inspect the gears and bearings. A report shall be forwarded to the owner each year over the first five years to confirm completion.

5. The impellers shall be fully shrouded and made of a high strength aluminum alloy. Impellers shall be dynamically balanced and over-speed tested at 1.25 times impeller shaft speed. Rotors shall

be of high grade steel alloy.

6. Acoustic package shall be either factory or field installed to enclose the compressor section to reduce radiated sound by a minimum of 5 dBA.

J. Evaporator and Condenser

1. The evaporator and condenser shall be built in accordance with ANSI/ASHRAE 15- Safety Code for Mechanical Refrigeration. Water boxes shall be designed for 150 psig maximum working pressure and shall be flanged and gasketed for easy removal and access to the tubes. The water boxes shall have grooved type water connections for easy field chilled water and condenser water connections.

2. Evaporator and Condenser tubes shall be internally enhanced and externally finned to achieve maximum efficiency. The nominal tube wall thickness shall be .028 inches for both evaporator and condenser tubes.

3. Adjustable or float type refrigerant metering devices and thermal expansion valves (TXV) shall be inspected and adjusted by the manufacturer annually for the first five years of operation to assure equivalent reliability to an electronic expansion valve (EXV) system. A written report shall be forwarded to the owner each year over the first five years to confirm completion of calibration.

4. Units with multi-stage compressors shall incorporate an inter-stage flash vessel economizer in the refrigerant cycle.

5. Factory insulation shall be 3/4" foam insulation and cover all low temperature surfaces to include the evaporator and water boxes, suction line, and motor housing.

K. Purge Or Pump-Out System

1. Units operating with refrigerant having positive pressure at 75 F (HFC-134a) shall have the capability of storing the entire refrigerant charge in the condenser or shall have a pump-out system for each machine complete with a separate transfer pump, condensing unit and tank constructed in accordance with ASME Code for unfired pressure vessels bearing the National Board stamp. Pump out systems shall be supplied and warranted by the centrifugal machine manufacturer. Pump-outs shall comply with the following:

   a. Pump-out tank(s) with ASME stamp capable of holding refrigerant charge when 80 percent full at 90F.

   b. Separate charging connections for liquid and gas refrigerant.

   c. Piping and valves between pump out and chiller to be supplied and installed by installing contractor. Contractor shall provide all piping, electrical equipment, and wiring required. Refrigerant piping shall be Type K hard-drawn copper with wrought copper fittings. Valves shall be packless type suitable for refrigerant use.

L. Controls:

1. The chiller(s) shall be controlled by a stand-alone direct digital control (DDC) system. A dedicated chiller control panel with a clear language display is to be supplied with each chiller by the chiller manufacturer. The controller shall provide chiller capacity control in response to the leaving chilled water temperature.

2. The chiller control panel shall utilize an Microprocessor which will automatically take action to prevent unit shutdown due to abnormal operating conditions associated with: evaporator refrigerant temperature, high condensing pressure and motor current overload.

3. In all of the above cases, the chiller will continue to run, in an unloaded state, and will continue to produce some chilled water in an attempt to meet the cooling load. However, if the chiller

reaches the trip-out limits, the chiller controls will take the chiller off line for protection, and a manual reset is required. Once the "near trip" condition is corrected, the chiller will return to normal operation and can then produce full load cooling.

4. The chiller control panel shall provide control of chiller operation and monitoring of chiller sensors, actuators, relays, and switches. The panel shall be a complete system for stand-alone chiller control and include controls to safely and efficiently operate the chiller.

5. The chiller control panel is to be provided with the following digital type pressure readouts:

   a. Evaporator refrigerant pressure
   b. Condenser refrigerant pressure

6. The front of the chiller control panel shall be capable of displaying the following in clear language as standard:

   a. Entering and leaving evaporator water temperature
   b. Entering and leaving condenser water temperature
   c. Chilled water setpoint
   d. Electrical 3 phase current limit and percent RLA setpoint
   e. Electrical 3 phase amp draw
   f. Chiller operating mode
   g. Condenser refrigerant temperature
   h. Elapsed time and number-of-starts counter
   i. Chiller compressor run status relay
   j. Diagnostics with time and date stamp
   k. Last 20 diagnostics with time and date stamp

7. The chiller control panel shall provide a relay output to start the condenser water pump and/or enable the cooling tower temperature controls.

8. The chiller control panel shall provide an alarm relay output that shall energize whenever a fault requiring manual reset is detected by the panel.

9. The chiller control panel shall provide a limit relay output that shall energize whenever the unit is operating in a limit mode (for extended time periods).

10. The chiller control panel shall provide a programmable soft load to prevent the chiller from achieving full capacity during the pulldown period by imposing a ramped current limit, or a temperature pulldown rate. Either can be adjusted to limit how fast the chiller can load after an initial startup.

11. The chiller control panel shall provide a chilled water pump output relay that closes when the chiller is given a signal to start.

12. The chiller control panel shall provide control of leaving chilled water setpoint with a minimum variation of chiller capacity.

13. The chiller control panel shall provide an RS-232 for printer interface to a printer.

14. The chiller control panel shall provide leaving chilled water temperature reset based upon return water temperature.

15. Each water chiller shall be supplied with a water regulating valve on the discharge of the condenser piping that will be tied into the chiller control panel to modulate based on differential pressure in the evaporator and condenser. Installation of valve and wiring to be completed by the mechanical contractor. The valve should be sized by the chiller manufacturer.

M. The Contractor shall include in his bid the required charges for the chiller manufacturer's factory trained field engineer to supervise the installation of the chillers, and witness the pressure testing,

evacuation and charging of the chillers. Further, the manufacturer's field engineer shall perform the initial start-up of the chiller including proper coordination with the Contractor on start-up of the cooling tower and associated condenser water and chilled pumps. Further, the chiller manufacturer's engineer shall instruct the Owner or his operator in the proper care and operation of the chillers for a period of 5 days, continuous or intermittent days, at the option of the Owner.

N. The Contractor shall include in his bid the required charges for the chiller manufacturer's factory trained field service engineer to perform necessary service including routine instruction on the chillers, cooling tower, condenser water and chilled water pumps, during the first cooling season of operation. This service shall include familiarization with the chiller control panel, and associated interlocks and controls on the cooling tower and pumps.

O. Starters (Low Voltage)

1. The motor starter shall be a wye-delta closed transition. Motor starter shall have NEMA 1 gasketed enclosure. Enclosure shall be constructed of 12 gauge steel minimum with the exception of doors which shall be 14 gauge steel minimum.

2. Starter shall be unit mounted with ventilating louvers.

3. Motor starters shall include incoming line provisions for the number and size cables shown on the electrical drawings. Incoming line lugs shall be aluminum mechanical type. Connection directly to the contactors is not permissible.

4. Contactors shall be sized properly to the chiller full load and locked rotor currents. Contactors shall have double break main contacts with weld resistant silver cadmium faces. Auxiliary interlocks that interface with the control panel shall be low resistance having palladium silver contacts.

5. Each motor starter shall include a control power transformer with fused primary and secondary. Current transformers of the proper size, ratio and capacity shall be provided to provide a signal to the control panel and optional devices. Control relays shall be provided within the motor starter to interface with the control panel.

6. Starter shall include an advanced motor protection system incorporating electronic three phase overloads and current transformers. This electronic motor protection system shall monitor and protect against the following conditions:

   a. Three phase overload protection
   b. Overload protection during start-up
   c. Phase imbalance
   d. Phase loss
   e. Phase reversal
   f. Low voltage
   g. Distribution fault protection consisting of three-phase, current sensing devices that monitor the status of the current. Distribution faults of 1-1/2 electrical cycle duration's shall be detected and the compressor motor shall be disconnected within six electrical cycles.
   h. Under/over voltage protection

7. The starter/control shall be designed and able to operate in temperatures up to 122 F.

8. All field supplied wires, bus bars, and fittings shall be copper only.

9. The following starter options shall be provided:

   a. Circuit Breaker - Starter shall contain a circuit breaker capable of interruption capacity per NEC. The disconnect handles, both internal and external, shall be capable of being padlocked in the off position.

b. Amps and volts shall be displayed at the control panel or ammeters and voltmeters provided. Three ammeters shall be provided, one per phase. Ammeters shall be calibrated to indicate the inrush current. Three voltmeters shall be provided, each reading a phase-to-phase voltage.

10. If solid state starter is provided a Shunt-Trip Circuit Breaker shall be provided. Starter shall contain circuit breaker with shunt trip device capable of interruption capacity per NEC. Operating handle shall be located on the starter panel. The disconnect handles, both internal and external, shall be capable of being padlocked in the off position.

P. Manufacturers: Carrier, 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.

2.2 FLUID COOLER (CLOSED-CIRCUIT TYPE) – INDUCED DRAFT

A. Manufacturers: Subject to compliance with requirements, provide closed circuit coolers manufactured by one of the following:

1. EVAPCO Model eco-ATWB
2. BAC Series HXV Hybrid Closed Circuit Cooler

B. The unit structure shall be designed, analyzed, and constructed in accordance with the latest edition of International Building Code (IBC) Regulations for seismic loads up to 1.0 g or wind loads up to 145 psf

C. Components

1. Description: Factory assembled and tested, induced draft counter flow closed circuit cooler complete with fan, coil, fill, louvers, accessories and rigging supports. Unit shall be a maximum of 14 feet high.

2. All cold-water basin components including water re-distribution basin, vertical supports, air inlet louver frames and panels up to rigging seam shall be constructed of Type 316 Stainless Steel. "Series 300" Stainless Steel will not be acceptable as equivalent to Type 316 Stainless Steel.

3. Upper Casing, channels and angle supports shall be constructed of heavy gauge mill hot-dip galvanized steel. Fan cowl and guard shall be constructed of galvanized steel. All galvanized steel shall be coated with a minimum of 2.35 ounces of zinc per square foot area (G-235 designation). During fabrication, all galvanized steel panel edges shall be coated with a 95% pure zinc-rich compound.

D. Fan(s):

1. Shall be high efficiency axial propeller type with aluminum wide chord blade construction. Each fan shall be statically balanced and installed in a closely fitted cowl with venturi air inlet for maximum fan efficiency.

E. Drift Eliminators

1. The eliminators shall be constructed entirely of Polyvinyl Chloride (PVC) in easily handled sections. Design shall incorporate three changes in air direction and limit the water carryover to a maximum of 0.001% of the recirculating water rate.

F. Water Distribution System

1. Spray nozzles shall be precision molded ABS, large orifice spray nozzles utilizing fluidic

technology for superior water distribution over the fill media and to minimize water distribution system maintenance. Spray header, branches, and riser shall be Schedule 40 Polyvinyl Chloride (PVC) for corrosion resistance. Branches shall have threaded end caps to facilitate debris removal.

G. Heat Transfer Media

1. Heat transfer coil shall be tightly spaced elliptical tubes of finned surface steel, encased in steel framework with the entire assembly hot-dip galvanized after fabrication. The coil assembly shall be designed with sloping tubes for liquid drainage and tested to 400psig air under water. Coil shall meet strength requirements of ASME/ANSI B31.5.

2. Fill media shall be constructed of Polyvinyl Chloride (PVC) of cross-fluted design and suitable for inlet water temperatures up to 130 F. The bonded block fill shall be bottom supported and suitable as an internal working platform. Fill shall be self-extinguishing, have a flame spread of 5 under A.S.T.M. designation E-84-81a, and shall be resistant to rot, decay and biological attack.

H. Pump

1. Unit shall have an EISA compliant, close-coupled centrifugal pump with mechanical seal. The pump shall be installed in a vertical position so that water will drain from the pump when the cold water basin is emptied. Pump motor shall be totally enclosed with protective canopy for outdoor operation.

I. Bleed-off

1. Unit shall have a waste water bleed line with adjustable valve provided.

J. Air Inlet Louvers

1. The air inlet louvers shall be constructed from UV inhibited polyvinyl chloride (PVC) and incorporate a framed interlocking design that allows for easy removal of louvers for access to the entire basin area for maintenance. The louvers shall have a minimum of two changes in air direction and shall be of a non-planar design to prevent splash-out, block direct sunlight and debris from entering the basin.

K. Electronic Water Level Control

1. Electronic water level control package shall have five (5) stainless steel water level sensors (one (1) high level, one (1) high level alarm, one (1) low level, one (1) low level alarm and one (1) ground) with a NEMA 4X enclosure mounted in a cleanable Schedule 40 PVC external standpipe with slow closing solenoid valve(s) and "y" strainer(s). Wiring is not included and components must be field mounted. Valves shall be sized for 25 psig (172 kPa) minimum to 125 psig (862 kPa) maximum pressure. Standpipe may require heat tracing by others in cold weather applications.

L. Pan Strainer

1. Pan Strainer shall be all type 304 stainless steel construction with large area removable perforated screens.

M. Fan Motor

1. Fan motor(s) shall be totally enclosed, ball bearing type electric motor(s) suitable for moist air service. Motor(s) are Premium Efficient, Class F insulated, 1.15 service factor design. Inverter rated per NEMA MG1 Part 31.4.4.2 and suitable for variable torque applications and constant torque speed range with properly sized and adjusted variable frequency drives.

N. Fan Drive

1. The fan drive shall be multigroove, solid back V-belt type with taper lock bushings designed for 150% of the motor nameplate horsepower. The belt material shall be neoprene reinforced with polyester cord and specifically designed for evaporative equipment service. Fan and motor sheave shall be aluminum alloy construction. Belt adjustment shall be accomplished from the exterior of the unit.

O. Fan Shaft

1. Shaft shall be Solid, ground and polished steel. Exposed surface coated with rust preventative.

P. Fan Shaft Bearings

1. Fan Shaft Bearings shall be heavy-duty, self-aligning ball type bearings with extended lubrication lines to grease fittings located on access door frame. Bearings shall be designed for a minimum L-10 life of 75,000 hours.

Q. Maintenance Access

1. Fan Section: Access door shall be hinged and located in the upper casing for fan drive and water distribution system access.

2. Basin Section: Framed removable louver panels shall be on all four sides of the unit for pan and sump access.

3. Internal Working Platform: Internal working platform shall provide for easy access to the fans, belts, motor, sheaves, bearings, all mechanical equipment and complete water distribution system. The fill shall be an acceptable means of accessing these components.

4. External Service Platform with Ladder: An OSHA approved external service platform shall be provided at the motor access door of the tower extending the full length of the of the access door. Each platform shall have at least a 36" walking surface. The platforms shall be galvanized steel grating, supported by galvanized steel framework attached to the tower and surrounded by a sturdy handrail, knee rail and kick plate system. Mounting channels shall be the same material as the casing section. A vertical ladder shall be provided from the base of the unit to the platform.

5. Motor Davit with Base: Unit shall be provided with mechanical jib-boom assembly which facilitates in removal of larger fan section components. Davit arm shall be constructed of aluminum and base shall be galvanized steel.

R. Accessories

1. Basin Heater Package: Cold water basin shall be fitted with copper-element, electric immersion heater(s) with a separate thermostat and low water protection device. Heaters selected to maintain +40 F pan water at 0 F ambient temperature.

2. Sump Sweeper Piping: Cold water basin shall be fitted with schedule 80 PVC sump sweeper piping complete with high-flow eductor nozzles to facilitate in basin cleaning. The system shall contain one inlet connection and one outlet connection per basin.

3. Heat Loss Protection: Closed Circuit Coolers with heat transfer coil below air inlet louvers shall utilize integral water re-distribution basin as heat loss protection. All Closed Circuit coolers that have heat transfer coil above the air inlet shall utilize a discharge hood with dampers and factory supplied insulation on coil casing and discharge hood. Closed Circuit Coolers with heat transfer coils exposed to ambient air conditions will not be acceptable.

S. Evaporative Cooling Water Treatment System – Factory Mounted

1. Description

a. Work Includes:

(1) Furnish all labor, materials, tools, equipment and services for spray water treatment system as indicated, in accordance with provisions of the contract documents.

(2) Completely coordinate with work of all other trades.

(3) See Division 1 for General Requirements.

(4) Services of manufacturer's representative company to provide automatically controlled water treatment programs and equipment as specified herein.

(5) Provide chemical treatment and supervision for the spray water treatment program, together with the necessary chemicals, designed to minimize corrosion, scale formation and biological growth in the following mechanical systems:

(a) Fluid Cooler Spray Riser Piping System

b. Description of System:

(1) Riser mounted, scale and corrosion inhibitor feeder by equipment manufacturer.

(2) Unit mounted Bio-Control Feeder by equipment manufacturer.

(3) Solid, controlled release chemicals as specified below.

(4) Factory mounted (by equipment manufacturer) conductivity controller and bleed valve as specified below. System shall be self-draining.

2. Submittals

a. Submit per the requirements Division 1.

b. Shop drawings: Show all water treatment equipment, including the following:

(1) Piping diagrams of all factory mounted components (show all field piping required, if any).

(2) Conductivity control panel and wiring diagrams (show all field wiring required). Include bill of materials showing model number, manufacturer, physical layout drawings, panel and equipment catalog cuts.

c. Operation and maintenance manuals: Include testing procedures for each of the treated systems.

d. List of chemicals and methods to be used for each system: Use generic names. Provide Material Safety Data Sheets (MSDS) for each chemical used.

e. Laboratory make-up water sample analyses: Submit a copy of the project site make-up water analysis to document the water quality available at the project site. Make-up water test analysis to include at a minimum the analysis of the following compositions of the water:

- Calcium Hardness (as ppm $CaCO_3$)
- Total Hardness (as ppm $CaCO_3$)
- Total Alkalinity or m-Alkalinity (as ppm $CaCO_3$)
- pH
- Silica (as SiO_2)
- Specific Conductivity (micro S/cm)
- Sulfate (as SO_4)
- Chloride (as Cl^-)
- Phosphate (as PO_4)

3. Quality Assurance

   a. The water treatment supplier shall:

      (1) Obtain water samples from the site and furnish a laboratory analysis of the water supply with submittal.

      (2) Review the make-up water analysis to ensure compatibility with the water treatment program.

      (3) Propose water treatment methods and appropriate chemicals required to minimize scale, corrosion and biological growth. Submit all of the above with shop drawings and other required submittals.

   b. Methods and chemicals selected shall comply with all the requirements of the American Public Health Association (APHA), the Environmental Protection Agency (EPA) and local environmental agencies.

4. Performance Criteria

   a. Maintain the following conditions listed below in the water systems:

      (1) Conductivity range of 300 to 5,000 micro S/cm.

      (2) pH range of 6.5 to 9.0.

      (3) Local environmental regulations may dictate the highest pH permitted for blowdown. The conductivity setting can be adjusted up or down to change the pH by the balancing of fresh make-up water.

      (4) Total bacteria count (TBC) of less than 10,000 CFU's/ml.

      (5) Keep condenser water system scale free and corrosion to levels acceptable by AWT guidelines.

   b. Passivation for Galvanized Steel: For the first 60 days of new equipment operation.

      (1) Calcium Carbonate Hardness: Maintain a minimum value of 50 PPM or more

      (2) M. Alkalinity: Maintain a maximum value of 300 PPM or less

      (3) pH: Maintain a value which will minimize the formation of White Rust in combination with the passivation treatment chemistry. In no instance shall pH be permitted to fall below 6.5

4. Water Treatment System

   a. Acceptable Products:

      (1) Chemical Feed & Control Equipment

         (a) Factory mounted inhibitor feeder
         (b) Factory mounted biocide feeder
         (c) Factory mounted conductivity controller, motorized bleed valve and torodial probe

   b. Chemicals

      (1) Chromates, zinc, or any liquid chemicals <u>shall not be used</u>.

      (2) Scale and corrosion inhibitors shall be non-toxic to humans and animals for the intended

use and for general storage and handling as required by the application.

(3) Phosphates are allowed as permitted by EPA and local authorities.

(4) Scale and corrosion inhibitors will be solid dry product with time released polymer coating for safe handling and easy reloading.

(5) The automatic chemical feed equipment shall operate and feed chemicals into each system only when the system is operating.

(6) Biocides shall be dry products fed thru factory mounted feeders and reloaded such that handling of the dry chemistry directly is not required.

c. Spray Water System:

(1) Chemical feeding and control equipment - condenser system: Provide the following apparatus (including all factory piping and wiring).

(a) One (1) factory mounted assembly for controlling conductivity and providing automatic chemical treatment to the condenser water systems. The assembly system shall have the following features and capabilities:

Conductivity monitor: Shall provide linear, temperature compensated measurements directly in micromhos over full scale. There will be a range of measurement provided, 100 to 3,000 micromhos. Conductivity measurement will be displayed on a LED display. Controller will have a USB port for downloading 60 days of operating data. USB port shall be used for retrieving operational frequency of bleed valve, output contact, make-up/bleed metering over a 60-day period.

i. Inhibitor feed: Inhibitor chemical will be fed directly from the unit riser pipe. A solid chemistry inhibitor shall be used with time released control mechanism. No pumps, timers or liquids shall be accepted.

ii. Biocide feed: Biocide chemical feeds will be controlled by a factory mounted feeder. Solid biocide will be fed directly into the recirculating stream. No pumps, timers or liquids shall be accepted.

iii. Basis of design – Evapco Smart Shield feeders and controller.

(b) The conductivity monitor, chemical feeders and sample stream piping assembly shall be mounted on the closed-circuit cooler or evaporative condenser. All components of the package system shall be pre-plumbed and pre-wired to form an operational and ready to install system. The package system shall consist of the following:

i. One (1) sample stream piping assembly consisting of:

- Two (2) ¾-inch inlet/outlet shut-off valves.

- One (1) conductivity probe of PVC construction, with a temperature compensating torodial probe mounted in the sample stream.

ii. One (1) pre-piped bleed-off piping assembly consisting of inlet shut-off valve, sample valve, throttling valve and motorized ball valve. Bleed-off piping assembly shall be sized to provide the proper bleed-off rate of the system. Bleed piping and controller should prevent the feed of biocide during the bleed cycle.

iii. One (1) factory mounted solid chemical inhibitor feeder, shall be provided for feed of the scale and corrosion inhibitor. Feed rate shall be adjustable based on a multiple chamber feeder arrangement.

iv. One (1) factory mounted solid biocide chemical feeder, shall be provided for feed of the biocide. Feeder shall be completely factory mounted for easy commissioning and refill.

(2) Water treatment chemicals - condenser system: Furnish 1-year supply of the recommended products for control of scale and corrosion in the open recirculating system. Additionally, furnish a 1- year supply of biocide for prevention of microbiological growth in the same system. The one year supply of chemistry shall be calculated based on the most efficient cycles of concentration the make-up water quality will allow. Biocide products recommended shall be properly registered with the Environmental Protection Agency and EPA registration number shall be clearly shown on all product literature and package labels. To ensure operator safety, all chemical products shall be provided in dry form for direct addition from shipping container to factory mounted feeders.

d. Testing equipment: Furnish basic water test equipment for maintaining control of program standards in the condenser water systems. Test kits will include the following:

(1) Reagents and apparatus for determination of corrosion inhibitor level in the condenser water systems.

(2) Reagents and apparatus for determination of pH, total alkalinity, free and total chlorine, and calcium hardness.

(3) Apparatus for determination of microbiological colony population and biocide effectiveness.

2.3 DUCTLESS SPLIT SYSTEM HEAT PUMP UNIT

A. Air conditioning system shall be a ductless split system heat pump. The system shall consist of a compact ceiling-mounted packaged evaporator section and matching outdoor air-cooled condensing unit. The units shall be listed by and bear the ETL label. All wiring should be in accordance with the National Electrical Code (N.E.C.). The units shall be rated in accordance with ARI Standard 240 and bear the ARI label. A full charge of refrigerant for 100 feet of refrigerant tubing shall be provided in the condensing unit. A dry nitrogen holding charge shall be provided in the evaporator. System SEER shall meet or exceed 1992 Federal Standards.

B. The indoor unit shall be factory assembled and wired. The casing fascia shall have a white or gray finish. The evaporator fan shall be an assembly with line flow fans direct driven by a single motor. The supply fan motor shall be multi-speed, permanent-split capacitor type with thermal overload protection and sealed, lifetime bearing. The fan shall be backward curved, centrifugal design, statically and dynamically balanced and run on permanently lubricated bearings. An adjustable guide vane shall be provided with the ability to change the air flow from horizontal to vertical. A motorized air sweep flow louver shall provide an automatic change in air flow by directing the air from side to side for uniform air distribution. Return air shall be filtered by means of an easily removable washable filter.

C. 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.

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

E. 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.

F. 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.

G. 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.

H. 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.

I. 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, 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.

J. Manufacturers: Airdale, Carrier, Daikin McQuay, EMI, 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.

2.4 REFRIGERANT GAS DETECTION SYSTEM

A. Refrigerant gas detection system supplier/installer shall be familiar with standard practices of safety and installation for refrigerant gas vapor detection systems and shall provide these systems as a normal course of business. Acceptable gas detection supplier shall provide a list of the last five (5) similar projects.

B. System shall meet or exceed the latest ASHRAE 15 requirement and EPA standard 608CFR. System shall incorporate all latest revisions.

C. System shall be capable of detecting presence of CFC, HCFC, or HFC refrigerant based on actual approved and installed chiller. System shall be capable of indicating, alarming and shutting down equipment as specified in this section and in governing regulations. Oxygen deficiency monitoring shall not be acceptable in lieu of TLV-TWA monitoring for human safety exposure.

D. Sequential sampling and multi-point monitoring shall be employed where air flow currents and room size prohibit a representative sample from one sensing point. Diluted samples due to ventilation air flow currents shall employ multi-point monitoring techniques strategically located according to regulation guidelines.

E. System design considerations shall also be incorporated in leak detection monitoring sensing location(s), for early warning indication to prevent a major loss of refrigerant without alarm, should a leak occur.

F. Analyzer shall be microprocessor-based and employ infrared (IR) sensor technology. It shall accurately provide sensing down to one part per million (ppm) and shall be compound specific and monitor compound as specified and be calibrated for refrigerant as required by approved chiller. Any installed unit can be switched to monitor, at a future date, to another refrigerant type by changing one part and recalibrating. Adjustable three level alarm for each point shall be supplied with common alarm output contacts. Provide local digital indication of ppm level for four sample points. Alarms shall be identified by an alarm message indicating the point in alarm and the alarm level. Unit shall have self-diagnostics, and supply a common malfunction output for alarm horn-beacon. Loss of sample flow at either sample or ZERO line will indicate system malfunction.

G. Four-point sequential sampling system shall be integrated into one analyzer enclosure. Microprocessor shall sequentially control required flow valves and communicated output signals to allow monitoring from multiple remote sampling locations. Unit shall read and hold output value of infrared sensor and control the corresponding four-point sequential sampling assembly. Each sampling point shall have adjustable sampling time and adjustable levels of alarm. Sample line capability up to 500 ft. The system shall have add-on sample point expansion capability for future expansion.

H. The system shall monitor and display accurately within the range of 0 to 25 ppm for refrigerant system and chiller diagnostics, detecting low level refrigerant leaks and deterioration of system efficiency.

I. Provide NEMA-rated wall mount enclosure with dust-tight door seal. Auto zero calibration shall be initiated at one-hour interval (adjustable) or manually at the monitor and shall automatically zero by drawing air from an uncontaminated air source. Include built-in sample pump and differential pressure flow switch for low flow indication. Provide four separate 4-20 mA dc analog outputs and one RS-485 output of refrigerant level(s). Unit shall be insensitive to vibration and shall provide for a continuous sample. Response time shall be twenty (20) seconds or less to ninety-nine (99%) percent of reading. Malfunction relay shall be energized due to flow loss or electrical malfunction.

J. The system shall be configured to provide relay board, with dry contacts for each channel, to initiate output signal for three level alarms at local panel, interface with both the Building ADT Security System and the Room Ventilation System. An early leak warning alarm shall be set at 10 ppm, regardless of refrigerant type, to prevent large refrigerant loss and provide chiller diagnostics. Other alarm level shall be set at or below the TLV-TWA level of 1000 ppm, R-134a.

At the TLV-TWA level, the system shall activate the purge ventilation system and sound a refrigerant leak alarm. Malfunction alarm indication and horn shall be provided. Provide dry alarm contacts for each alarm level.

K. Installation: Unit shall be factory calibrated. Field calibration is unacceptable at time of installation.

L. Maintenance & Calibration: No calibration shall be required for a period of one (1) year from date of installation. Zero filter and end of line filters shall be replaced every six months or sooner, based on usage.

M. Manufacturers: General Analysis Corporation, Gensis International, Inc., Yokagawa Corporation, Thermal Gas Systems, Inc., MSA Co.

PART 3 – EXECUTION

3.1 REFRIGERATION EQUIPMENT

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

3.2 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.

3.3 INSTALLATION OF ROTARY SCREW WATER CHILLER

A. Install in accordance with manufacturer's instructions.

B. Provide for connection to electrical service.

C. Provide Neoprene Isolation Pads to reduce vibration transmission.

D. On units without unit mounted starters provide for connection of electrical wiring between starter and chiller control panel, oil pump, and purge unit.

E. Provide necessary auxiliary water piping for oil cooling units and purge condensers.

F. Arrange piping for easy dismantling to permit tube cleaning.

G. Provide piping from chiller relief valve to outdoors. Size as recommended by manufacturer and ANSI/ASHRAE Standard 15.

H. 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 cooling tower, pumps, interlocks, etc. as applicable.

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.

3.5 REFRIGERANT GAS DETECTION SYSTEM

A. Install system in accordance with manufacturer’s written instructions.

B. Install sensing lines, alarm lights and horns as shown on the drawings.

C. On high level alarm, system shall shut down boilers and start emergency ventilation system.

3.6 COOLING TOWERS

A. Examine proposed route of moving cooling towers into place and verify that it is free of interferences.

B. Examine elements and surfaces to support cooling tower.

C. Verify piping and wiring roughing-in locations.

D. Verify suitability of branch-circuit wiring.

E. Install cooling towers according to manufacturer's written instructions.

F. Install cooling towers level and plumb, and fasten to supporting structure with vibration isolators and seismic restraints.

G. Maintain recommended clearances for service and maintenance.

H. Electrical Wiring: Install electrical devices furnished by cooling tower manufacturer that are not factory mounted.

I. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.

3.7 TOWER CLEANING SYSTEM

A. Coordinate with the Mechanical Contractor to ensure equipment is installed in conformance with manufacturer's recommendations and those found in the specification.

B. Provide factory-designed configuration of HydroBoosters for maximum efficiency and effectiveness.

C. If deficiencies are noted by the field service representative, the Mechanical Contractor shall make necessary correction and the manufacturer's field service personnel will visit the installation site and oversee any corrections or modifications required. A written report shall be field with the Owner's Representative visit.

D. The separator shall feature the following access capabilities for either inspection or the removal of unusual solids/debris:

1. A hand-hole port at the collection chamber.
2. A ½-inch inspection port, located at the lowest point of the upper chamber.
3. A grooved coupling in the upper body to provide full access.

END OF SECTION 230450

SECTION 230500: 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-line shall be a minimum of 3 times pipe size for standard units and 4.5 times pipe size for high velocity units. Vessel shall extend below nozzle center-line the same distance for dirt separation.

D. Units shall include an internal bundle filling the entire vessel to suppress turbulence and provide high efficiency. The bundle shall consist of a copper core tube with continuous wound copper medium

permanently affixed to the core. A separate copper medium shall be wound completely around and permanently affixed to each internal element.

E. Each eliminator shall have a separate venting chamber to prevent system contaminants from harming the float and venting valve operation. At the top of the venting chamber shall be an integral full port float actuated brass venting mechanism.

F. Units shall include a valved side tap to flush floating dirt or liquids and for quick bleeding of large amounts of air during system fill or refill.

G. Unit shall include a blow down valve at bottom for removal of collected dirt and sediment.

H. Air eliminator function shall be capable of removing 100% of the free air, 100% of the entrained air, and up to 99.6% of the dissolved air in the system fluid during continuous circulation.

I. Dirt and sediment separator function shall be capable of removing 80% of particles 30 micron and larger within 100 passes. A properly selected strainer shall be installed upstream to collect large debris that may be left in the piping.

J. (Optional) Provide removal head to facilitate internal element inspection or cleaning if required. Elements shall include tube sheets top and bottom and be manufactured as a bundle for ease or removal. Verify space required for bundle removal.

K. Manufacturer: Spirovent® model VDT for standard velocity or model VHT for high velocity systems or equal in size and construction. (VDN standard velocity or VHN high velocity for optional removable head.)

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, 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 230500

SECTION 230510: WATER TREATMENT (HVAC)

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

B. Refer to Section 230200 for HVAC General Provisions.

C. Refer to Section 230210 for HVAC Basic Materials & Methods.

1.2 DESCRIPTION OF WORK

A. This Section includes labor, material, equipment and supervision to provide a complete water treatment system for the following:

1. Cleaning and treatment of circulating HVAC chilled water system, hot water and steam system.

a. Cleaning Compounds.
b. Chemical Treatment for Closed Loop Systems.
c. Glycol Water Systems
d. 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.
3. Glycol water heat transfer 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 GLYCOL-WATER SYSTEMS

A. Propylene glycol shall be inhibited with 1.75 percent dipotassium phosphate. Do not use automotive anti-freeze because the inhibitors used are not needed and can cause a sludge precipitate that interferes with heat transfer.

B. Contractor shall provide required amount of glycol to obtain the percent by volume for glycol-water systems as follows and to provide one-half tank reserve supply:

1. 30% propylene-glycol for cooling tower condenser water systems.

C. Pot Feeder Make-up Unit: Bypass type for chemical treatment, Schedule 10 gauge heads, 3/4" system connections and large neck opening for chemical addition. Feeders shall be two (2) gallon minimum size.

D. Glycol-Water Make-up System:

1. Glycol-Water Storage Tank: Self-supporting or polyethylene, minimum 90 mil thickness, with removable cover or black steel with 90 mil polyethelene insert. Capacity shall be 55 gallons, with approximate diameter of 23 inches and height of 36 inches. Reinforced threaded pipe connections shall be provided for all connections. Provide identification for tank showing name of the contents.

2. Glycol-Water Make-up Pump: Bronze fitted, self-priming, high head type suitable for pumping a 33 percent to 50 percent glycol-water solution in intermittent service. The pump shall be provided with a mechanical shaft seal and be flange connected to a 1750 rpm NEMA Type "C" motor. The pump capacity shall be three gpm, 50 psig discharge pressure with a suction lift capability of five inches of mercury, with a 1/3 horsepower drip-proof motor. The pump may be a "gear-within-a-gear" positive displacement type with built-in relief valve set for 43 psig, or the pump may be a regenerative turbine type providing self-priming with built-in or external relief valve set for design head of the pump.

3. Back pressure regulating valve: Spring loaded, diaphragm actuated type with bronze or steel body, stainless steel trim with capacity to relieve 100 percent of pump flow with an allowable rise in the regulated pressure of 10 psi above the setpoint. Setpoint shall be 15 psi above system PRV setting.

4. Low Water Level Control: Steel or cast-iron float housing, stainless steel float, positive snap-acting SPST switch mechanism, rated 10 AMPs-120 volt AC, in General Purpose (NEMA 1) enclosure. The control shall be rated for pressures to 150 psig and make alarm circuit on low water level. The alarm circuit shall be wired to an alarm light on the nearest local temperature control panel.

E. Propylene Glycol:

1. Inhibited, propylene glycol based fluid shall be suitable for a temperature range of -50°F to 250°F.

2. Fluid shall have special industrial inhibitors designed to prevent corrosion within piping systems and accessories for HVAC service.

3. Fluid shall provide burst protection for condenser water system with a solution concentration of 30% by volume.

4. Typical physical properties: (Based on 50% concentration by volume, at 40°F)

   a. Max operating temperature, 320°F.
   b. Freezing point, -28°F.
   c. Thermal conductivity, 0.204 Btu/(hr-sf) (F/ft).
   d. Specific heat, 0.794 Btu/lb-F.
   e. Viscosity, 14.0 cps.
   f. Density, 66.68 lb/cf.
   g. Color, fluorescent yellow.

5. Manufacturers: Dow Chemical Co., DOWFROST HD.

F. Initial change of propylene glycol and water shall be delivered to the jobsite complete and factory mixed to the proper proportions for pumping into the condenser/cooling tower piping system. Mixing on site is not acceptable.

2.4 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 230510

SECTION 230600: 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. Flexible Connections
6. Dampers
7. Fire Dampers
8. Air Diffusers, Registers and Grilles
9. Prefabricated Roof Curbs and Equipment Supports
10. Louvers
11. Sound Attenuation
12. Duct Access Doors (Interior)
13. Duct Access Doors (Exterior)
14. Fabric Air Dispersion Ductwork

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, 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 inches 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.

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 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.

2.6 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.

2.7 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.

2.8 AIR DIFFUSERS, REGISTERS AND GRILLES

A. Air diffusing terminals shall be provided in duct runs on drawings. The diffusers shall properly and uniformly distribute the design air quantity with no objectionable drafts, while maintaining not more than 50 F. P. M. velocity in the occupied portion of the space.

B. Ceiling Diffusers:

1. Square Louvered Diffuser Face:

   a. Square housing, welded steel construction core of square concentric louvers, removable at face of diffuser, round duct connection, with borders suitable for lay-in ceiling tile application.

   b. Diffuser Patterns: Fixed louver face for 1, 2, 3, or 4 direction air flow, direction indicated on drawings.

   c. Finish: Matte white finish.

   d. Manufacturers: Price Model SMD

2. Linear Diffusers:

   a. Linear diffusers shall be horizontal continuous slot type with multiple slots per the schedule and drawings. Construction shall be extruded aluminum with 1/2", 3/4" or 1 " slots. The diffusers shall have integral devices to equalize air flow over the entire length of the diffuser.

   b. Multiple sections of diffusers shall be installed in a continuous arrangement, the butt ends shall be provided without flanges to provide a continuous effect. Multiple sections shall be aligned and fastened with alignment pins and slots or a similar method.

   c. Linear diffusers shall be provided with adjustable vanes to provide horizontal, vertical or midway patterns of air diffusion. Finish as selected by Architect.

3. 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

7. Ceiling Louvered Return Filter Grille (CR):

a. Return filter grilles shall be of size and mounting type as shown on the drawings and schedules.

b. Borders shall be constructed of steel with countersink holes or frame suitable for ceiling finish in each room.

c. The four corners shall be interlocked and mechanically staked to form a rigid frame.

d. Deflection blades shall be ½ inch spacing, 45° deflection.

e. Return grilles shall be provided with a filter frame that will accommodate a standard 1-inch thick disposable filter to fit the specified duct size. Filter shall be grille module size minus 4 inches. Filter capacity shall be as scheduled on the drawings.

f. Return grille finish shall be white powder coat.

g. 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

2.9 PREFABRICATED ROOF CURBS AND EQUIPMENT SUPPORTS

A. Factory fabricated by the manufacturer of the respective roof-mounted equipment when available and capable of meeting the following requirements:

1. Thermally and acoustically insulated, rubber isolating pads.

2. Built to suit slope of roof and type of roofing; i.e. standing metal seam with integral cant strip and flashing extension.

3. 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.

2.10 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.

2.11 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.

2.12 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.

2.13 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.

2.14 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. (V)
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, Q Sox by Fabric Duct Systems, Inc., Air Sox by Euro Air, Hero Fabri Duct by Hero Fabri Duct, Inc., Fabric Air Inc., or KE Fibertec.

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 230600

SECTION 230605: 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. Recessed Ceiling Fan
2. Roof-Mounted Exhaust Fans
3. Vertical Discharge exhaust Fan (Kitchen, Dishwashing)

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 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.

2.2 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.

2.3 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. Special motors for high heat and explosion-proof shall be provided where indicated in the schedule.

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

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 230725: 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. Fin-Tube Radiation
5. Steel Radiators

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, 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, 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, York/Johnson Controls, The Coil Co., Trane, USA Coil.

2.4 FIN-TUBE RADIATION

A. Provide fin-tube heating elements and enclosures, together with required mounting components and accessories.

B. Heating Elements shall consist of full-hard aluminum plate fins not less than .016" thick and actually embedded in copper seamless-drawn tube guaranteed for working pressure of at least 150 psi at 300 deg. F temperature.

C. Enclosures and accessories:

1. Shall be of style and dimensions indicated on plans and shall be fabricated from 16-gauge zinc-coated steel. Top of enclosures and 90 deg. corners shall consist of a heavy continuous enclosure, with vanes sloped toward room, factory assembled to steel front skirts. Enclosure top shall have pencil-proof air discharge slots.

2. Bottom of enclosure skirt shall have a double break for lateral stiffness, top shall be provided with deep-web gussets, and vertical stiffeners with 1/2" deep flanges shall be provided at enclosure joints.

3. Enclosures and 90 deg. corners shall have flush joints with no exposed fasteners. End enclosures and end trims shall have roll- flanged edges, allowing enclosures to telescope within, and shall have no visible fasteners.

D. Support components:

1. Shall consist of continuous mounting channel and bracket and element hangers installed every 3 to 4 feet.

2. Continuous 20-gauge roll-formed mounting channel, fabricated from zinc-coated steel, shall position extruded aluminum top 7/8" from wall.

3. The mounting channel shall be provided with a 16-gauge back plate, covering all holes and slot in channel, and flanged at bottom.

4. Support brackets shall be die-formed from 3/16" thick steel, 1-1/2" wide and shall be lanced to receive bottom flange of enclosure, which shall be held securely with set screw.

5. 16-gauge die-formed saddle shall positively position heating element away from brackets and enclosure joints and allow 1-5/8" lateral movement for expansion and 1-1/2" height adjustment for pitch. Nylon-coated support arm shall allow free-sliding of saddle.

E. Access doors shall be provided where indicated. Doors shall be at least 8" x 8" size, hinged, located in enclosure front skirt and provided with tamperproof operator.

F. Finish: All parts of the enclosure shall be primed and painted.

1. Factory applied enamel finish, color as selected by the Architect from manufacturer's standard color chart.

G. Manufacturers: Vulcan Model DV, Embassy Industries, Rittling, Slant/Fin, Sterling, Trane.

2.5 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.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which equipment is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF UNIT HEATERS

A. Install heaters in accordance with manufacturer's installation instructions.

B. Uncrate units and inspect for damage. Verify that nameplate data corresponds with unit designation.

C. Hang unit from building substrate.

D. Protect units with protective covers during balance of construction.

3.3 INSTALLATION OF CABINET HEATERS

A. Install cabinet heaters in accordance with manufacturer's installation instructions.

B. Locate cabinet heaters as shown on the drawings. Coordinate with other trades.

C. Protect units with protective covers during balance of construction.

3.4 DUCT HEATING COILS

A. Install in accordance with manufacturer's recommendations.

B. Coil casing dimensions shall not be less than approach duct dimensions.

C. Comb fins if damaged. Install safing to eliminate air bypass or leakage at coil sections.

3.5 FIN TUBE RADIATION AND 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. Fin Tube Radiation: Enclosures shall be run continuously, wall-to-wall.

END OF SECTION 230725

SECTION 230760: 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. Blower – Coil Air Handling Unit
2. Packaged Air-to-Air Energy Recovery Unit
3. Single Packaged, Gas-Fired Rooftop Air Conditioning Unit
4. Packaged Gas-Fired Rooftop Unit (Kitchen Ventilation)
5. Packaged Rooftop HVAC Unit with Energy Recovery

1.3 REFERENCE STANDARDS

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

B. AMCA Standards 210 and 300 for fans.

C. ARI Standard 410, ASHRAE Standard 33 for Heating and Cooling Coils.

D. ASHRAE Standard 52.2 and U.L. Standard 900 for media type air filters.

E. AMCA Standard 511 and 500D for Air Control Dampers.

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

G. ARI Standard 260 and 430 for Air Handling Units.

1.4 QUALITY ASSURANCE

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

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

1.5 SUBMITTALS

A. Submit shop drawings in accordance with Section 230200.

B. Submit shop drawings and descriptive 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 BLOWER – 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 18-gauge steel that have been finished with baked enamel to provide a long-lasting, quality appearance. Casing shall be insulated with one inch (1”) 1-1/2 lb. density fiberglass, 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.

C. Fans shall be SWDI, forward-curved, centrifugal blower type equipped with heavy duty adjustable speed V-belt 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.

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.

E. V-Belt Drive shall:

1. Be rated at least 25% above the required HP.

2. Permit the blower RPM to be adjusted to meet the exact CFM requirement of the system.

F. Water Coils:

1. Main coils shall be two, four or six row chilled or hot water, 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, plastic or mastic coated steel, fully drainable, main and auxiliary connections of ¾" PVC or threaded pipe.

G. Mixing Box:

1. Section constructed of heavy gauge galvanized steel, treated similar to unit cabinet.

2. Provide two low leak parallel blade dampers factory linked with drive rod extended to accommodate motor actuator external to the section. Return air damper shall be parallel blade, outside air damper shall be opposed blade.

3. Damper blades shall be extruded aluminum with interlocked edge seals and frame seals.

4. Dampers shall be suitable for temperature range of -50 to 230ºF.

5. Section shall include two, side access panels.

H. 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 PACKAGED AIR-TO-AIR ENERGY RECOVERY UNIT (GENERIC)

A. Factory fabricated and assembled unit consisting of constant volume fans, motors, and drive assemblies, coils, plenum casing, filters, energy recovery wheel (with motor and drive), motor-operated outside air and exhaust air dampers, access doors and operating controls.

B. Casing:

1. Casing panels shall consist of dual wall, minimum 18-gauge galvanized solid exterior skins and 22-gauge galvanized steel solid interior skins enclosing 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.

2. 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.

3. 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. Handles are to be internal and external for opening from the inside or outside of the unit.

4. The unit's duct connections shall be arranged to require only minor ductwork offsets or transitions to the packaged heating/cooling unit.

5. Unit features and casing shall be of weatherized construction including:

   a. Continuous 18-gauge galvanized steel, pitched watertight roof with standing seams.
   b. Gasketed sections requiring no caulking at the job site.
   c. Internal galvanized steel drain pans in each section.

C. Fans:

1. 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.

2. 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.

3. 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.

4. 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 frequency drives.

5. Motors shall be standard NEMA frame, design B high efficiency, with 1.15 service factor and open drip-proof enclosures. 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. Motors shall be rated for inverter duty.

D. Total Energy (Enthalpy) Recovery Wheel:

1. 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.

2. 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.

3. 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.

4. 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.

5. Rotor System:

a. 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.

b. 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.

c. 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.

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

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

E. Filters:

1. Provide filters for both inlet air streams, outside air and return air.

2. Filters shall be disposable 2" thick, MERV 8. The filter shall be listed by Underwriters' Laboratories as Class 2.

3. Provide a bank of galvanized universal holding frames arranged for upstream access.

F. Electrical: 460 volt, 3 phase, 60 Hz; electrical features shall include single point power feed termination, unit-mounted lockable disconnect, internal circuit breaker type overload protection, starters, 24 VAC control transformer and fusing.

G. Connections: System field connections shall be limited to:

1. Supply air duct connection from the packaged unit.
2. Return air duct connection to the packaged unit.
3. Field supplied power source.
4. Twisted pair, ATC communications wiring.
5. Piping connections for natural gas system piping and condensate drain.

H. Condenser Section

1. The condensing section shall be equipped with direct drive, vertical discharge condenser fan(s). The condenser coil shall be sloped at least 30 degrees from horizontal to protect the coil from damage.

2. Condenser coil(s) shall be copper tube with aluminum fins mechanically bonded to the tubes.

3. Condenser coil(s) to be sized for a minimum of 10 degrees sub-cooling.

I. Evaporator Coil

1. Evaporator coil shall be multi-row minimum ½" copper tube with aluminum fins mechanically bonded to the tubes, with galvanized steel end casings, and equalizing type vertical tube distributors.

2. Evaporator coils for multi-compressor units shall be circuited with one circuit and expansion valve per compressor.

3. Unit shall be equipped with a double sloped, mastic coated drain pan, and outlets on either side of unit.

J. Refrigeration System

1. Compressor(s) shall be of the scroll type with crankcase heater(s), internal thermal overload protection, internal spring isolators and mounted on the compressor manufacturer recommended rubber vibration isolators.

2. All units over 7 tons shall be multiple stage and shall have a minimum of 2 stages of capacity control.

3. Compressor(s) shall be mounted in an isolated compartment to permit operation of the unit without affecting air flow when the compressor compartment is open.

4. Compressor(s) shall be isolated from the base pan and supply air to avoid any transmission of noise from the compressor into the building.

5. System shall be equipped with thermostatic expansion valve(s) type refrigerant flow control, automatic re-set low pressure and manual reset high-pressure refrigerant controls, Schrader type service fittings on both the high side and low-pressure sides of the system, refrigerant liquid line driers, and factory charged with refrigerant.

6. Unit shall be equipped with five-minute time delay and twenty second staging relays, and hot gas bypass no-load valves and piping for each refrigerant circuit.

K. Hot Gas Reheat Coil – Modulating:

1. Unit shall be equipped with a two row 5/8” copper tube, hot refrigerant gas reheat coil.

2. Coil shall be copper tube with aluminum fins mechanically bonded to the tubes.

3. Hot gas distribution shall be accomplished with a factory installed solenoid and modulating thermal expansion valve piped into the lead refrigerant circuit.

4. Unit shall have a control circuit and logic to operate the modulating hot gas valve.

5. Unit control block shall have terminals to control the hot gas reheat function.

L. Gas Heating Section:

1. Unit shall be equipped with a fully modulating heating section using natural gas fuel, minimum 4 to 1 turndown.

2. Unit shall be provided with a gas heating furnace consisting of an aluminized steel or stainless steel tubular heat exchanger, an induced draft blower, and an electric pressure switch to lock out the gas valve until the combustion chamber is purged and combustion air flow is established.

3. Unit shall be provided with a gas ignition system consisting of an electronic ignitor to a pilot system, which will be continuous when the heater is operating, but will shut off the pilot when heating is not required.

4. Unit shall have gas supply piping entrances in the unit base for through the curb gas piping and in the outside cabinet wall for across the roof gas piping.

5. Units tubular heat exchanger shall carry a twenty-five (25) year warranty.

M. Power/Electrical Section

1. Unit shall be equipped with a single point electrical connection with VFD motor starters, relays, voltage transformer and terminal block for controls interface, factory mounted disconnect switch.

2. Unit shall include a laminated, color coded electrical wiring diagram attached to the door of the unit. Damper actuators shall be wired to the units low voltage terminal block. All components are UL listed, approved, or classified.

N. Roof Curb: Prefabricated galvanized steel mounting curb shall be provided for field assembly on the roof decking prior to unit placement. The roof curb shall be a perimeter type with complete perimeter support of the air handler unit. The curb shall be a minimum of 12” high. Gasketing shall be provided for field mounting between the unit base and roof curb. Curb shall include a 2” x 4” wood nailer.

O. Manufacturers: Basis of design, York. Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work are limited to one of the following:

Addison
Annexaire
CanFab, Inc.
Desert Aire
Greenheck
Innovent
Loren Cook
Temtrol
Thybar Corp.
Valent
VenMar

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. A unit-mounted potentiometer shall be provided to adjust the outdoor and return air damper assembly to take in minimum scheduled or 10% CFM of outdoor air.

4. During economizer operation, a mixed air temperature control shall modulate the outdoor and return air damper assembly to prevent the supply air temperature from dropping below 55 deg. F.

5. Changeover from mechanical refrigeration to economizer operation shall be provided by single-point outdoor air enthalpy control.

6. 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.

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.

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.

2.5 PACKAGED ROOFTOP HVAC UNIT WITH ENERGY RECOVERY

A. Refrigeration System – Refrigerant R-410A:

1. One independent refrigeration circuit with hermetic compressor, crankcase heater, strainer, high and low pressure control, compressor motor protection, access valves, hot gas bypass, solid core liquid line filter driers.

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 24” high 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 and natural gas to propane conversion kit.

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.

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.

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, the following items as described in Section 230900: ATC.

B. Constant volume rooftop units:

1. The following items shall be provided by the equipment manufacturer:

   a. Motor starters and overload protection.
   b. Control transformers.
   c. Energy wheel motor, speed controller, defrost controller, rotation failure contact, and status contact.
   d. Dampers and damper motors.
   e. Terminal blocks for all wiring connections between equipment and control devices.
   f. Analog air filter differential pressure sensor.
   g. Manual reset freeze stat.
   h. Variable frequency drives as scheduled.
   i. Run status dry contact for each VFD.

2. The following items will be furnished by the BAS Contractor and installed by the equipment manufacturer:

   a. DDC Controller
   b. Discharge air temperature sensor.
   c. Discharge humidity sensor.
   d. Return air temperature sensor.
   e. Return air humidity sensor.
   f. Temperature sensor at exhaust air outlet.
   g. Current sensor for one phase of power feeding the supply fan, and/or unit exhaust fan.
   h. Mixed air average temperature sensor.
   i. Heating coil discharge air temperature.

3. The following items shall be field mounted and wired by the BAS Contractor:

   a. Discharge air temperature sensor.
   b. Discharge humidity sensor.
   c. Heating coil discharge air temperature sensor.
   d. Manual reset freezestat (supplied by ATC).

C. Rooftop Energy Recovery Units:

1. The following items shall be provided by the equipment manufacturer:

   a. Motor starters and overload protection.
   b. Control transformers.
   c. Energy wheel motor, speed controller, defrost controller and rotation failure contact.
   d. Dampers and damper motors.
   e. Terminal blocks for all wiring connections between equipment and control devices.
   f. Analog air filter differential pressure sensor, each filter bank.
   g. Manual reset freeze stat.

2. The following items will be furnished by the BAS Contractor and installed by the equipment manufacturer:

a. DDC Controller.
b. Unit discharge air temperature sensor.
c. Heating and cooling coil discharge air temperature sensors.
d. Discharge humidity sensor.
e. Return air temperature sensor.
f. Return air humidity sensor.
g. Temperature sensor at exhaust air outlet.
h. Current sensor for one phase of power feeding the supply and exhaust fans.

3. The following items shall be field mounted and wired by the BAS Contractor:

a. Discharge air temperature sensor.
b. Discharge humidity sensor.
c. Heating coil discharge air temperature sensor.
d. Manual reset freezestat (supplied by ATC).

D. The factory mounted DDC controllers shall be fully programmed with factory approved applications. Any modifications to these programs shall be done by factory trained personal or as approved by the DDC controls and unit equipment manufacturer.

The unit equipment manufacturer shall provide coordination for start-up, check-out, and test of the factory mounted DDC controllers and network devices including the protocol translator. Any hardware and software necessary including labor shall be provided by the unit equipment manufacturer.

The unit DDC controllers shall be networked to a standard protocol translator or gateway so system points shall be available for communications and control from the Building Automation System (BAS)/Automatic Temperature Controls (ATC) System. The protocols available from the protocol translator to the BAS/ATC System shall be BACNET (MSTP), LON or N2.

System points shall be configured to the BAS/ATC System by the BAS/ATC System Contractor. The mapping of points to the BAS/ATC front-end/PC shall be done by the BAS/ATC Contractor. Any software or hardware necessary including labor to accomplish this work shall be provided by the BAS/ATC System Contractor.

END OF SECTION 230760

SECTION 230900: 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 temperature controls with a host PC and full color graphics to control all HVAC Systems, associated components and accessories as described herein.

1.3 SUBMITTALS

A. Submit shop drawings and manufacturer's data sheets of all equipment.

B. Submit manufacturer's certificates of conformance with applicable codes.

C. Furnish point-to-point diagram of automatic temperature control system approval, including heating, ventilating and air conditioning equipment wiring diagrams where temperature control connections are required.

D. Provide 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 135-2012, BACNET.

F. All system components shall be designed and built to be fault tolerant.

1. Provide satisfactory operation without damage at 100% above and 85% below rated voltage and at +3 Hertz variation in line frequency.

2. Provide static, transient, and short circuit protection on all inputs and outputs. Communication lines shall be protected against incorrect wiring, static transients and induced magnetic interference. Bus connected devices shall be A.C. coupled or equivalent so that any single device failure will not disrupt or halt bus communication.

1.5 ELECTRICAL WIRING

A. All electrical wiring, components and accessories in connection with the Automatic Temperature Control System shall be furnished and installed by the control manufacturer.

1. Electrical Contractor shall provide all wiring to duct smoke detectors.

2. 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 the Custodian's Office C112 as shown on the drawings and shall meet the following minimum criteria:

1. A Personal Computer (PC) based central, with minimum Intel Pentium Processor 2.8 GHz minimum clock speed, and Intel motherboard. PC shall be provided with a minimum of 2 GB of RAM, 1.44 MB diskette, 6 USB ports on the back and 2 on the front, 80 GB EIDE hard drive suitable for peripherals and applications herein specified and DVD ROM. Operator Work Station (OWS) shall include mouse, keyboard, ink-jet printer and 19-inch flat panel, monitor, an internal 56K modem connected to a PCI slot, and "NIC" card for network interface.

2.2 TEMPERATURE SENSORS

A. Solid state room sensors shall be of the wire wound resistance type element. Sensors shall be equipped with visual readout and adjustment. Sensors shall be of the completely solid state type with no moving contacts. Printed circuit board under thermostat cover shall contain a low mass resistance type setpoint dial and amplifier. Provide test points for measuring output voltage. Sensors shall be direct or reverse acting as required for the sequence of operation.

B. Sensors shall provide the application for night setback override.

C. Sensors shall be mounted at ADA height (48" above floor).

2.3 SMOKE DETECTORS

A. Duct type ionization smoke detectors shall be furnished by the Electrical Contractor and installed by the Mechanical Contractor in the supply and return air stream. The Electrical Contractor shall provide wiring from each detector to the Fire Alarm System panel.

B. The Electrical Contractor shall provide an alarm output signal from the FAS panel to the BAS for unit shutdown.

2.4 ACTUATORS

A. Electronic actuators shall be sized to operate their appropriate dampers and valves with sufficient reserve power to provide smooth modulating action or two-position action as specified.

B. Provide integral, auxiliary switches for direct coupled actuators to indicate when a desired position is reached or to interface additional controls for a specific sequence.

C. Align actuator with drive shaft, provide permanent mark to identify closed position of end device.

2.5 SENSOR TRANSMITTERS

A. Duct and immersion sensors shall have minimum spans as required to meet the temperature requirements. Duct sensors shall have sensing elements of sufficient length and accuracy to measure average duct temperature in each location.

B. Sensors shall be of corrosion resistant construction, tamperproof, suitable for mounting on a vibrating surface. Exposed capillaries shall be temperature compensated, and armored or installed in protective tubing.

C. All sensing elements for water pipe mounting shall be of the rod and tube type with linear output and shall be furnished complete with separable protecting wells filled with heat conductive compound. Sensors shall be factory calibrated and tamperproof. If easily adjustable sensors are provided, they shall be located inside metal enclosures with cylinder lock and key to prevent unauthorized setting.

D. Safety Devices: Provide the following:

1. Low limit, electric type, with 20' long serpentine element, with manual reset, set for 37°F for "freeze" protection and 55°F for fan discharge application, unless otherwise noted.

2. Air and water duty flow switches: Current sensor type for fan and pump status.

3. Carbon dioxide sensor/transducer suitable for wall or duct mounting.

   a. Analog output of 4 to 20 milliamps corresponding to 0 to 2000 ppm CO2.
   b. ABS plastic housing, suitable for an operating environment of 0 to 125 F/ 0 to 100% RH, non-condensing.
   c. Repeatability less than +/- 20 ppm.
   d. Response time less than 60 seconds.
   e. Power supply, 24 VAC.
   f. Make: Vaisala Inc. model GMW 21 (wall)
      GMD 20 (duct)
   g. Manufacturers: Air Test Technologies, Inc., Macurco, Rotronic Instrument Corp., Vaisala, Inc.

4. Make-up Water Monitoring System (Typical for chilled water & hot water heating system): (Manufacturer's Rep. 888-397-5353)

   a. Monitor data as received by flow meter on cold water make-up system. When flow exceeds 10 gal./1 min (adj.), ATC system to close normally open solenoid valve, alarm system (provide call out), shutdown boilers, pumps, chillers, etc., associated with respective system.

   b. Flow sensor, consisting of a removable flow sensor mounted in cast bronze housing, available in ½" to 1-1/2" pipe size. Sensor shall be rated for a flow range of 0.5 to 15 feet per second, 220°F max., 400 psig at 100°F max. pressure; Nylon impeller, Pennlon bearing, tungsten carbide shaft, PPS housing and EPDM seals. Manufacturer: Kele Model 250B, Data Industrial Series 250BR.

   c. Programmable analog flow transmitter shall be a loop-powered device that converts a flow sensor signal into a linear 4 – 20 mA signal. Electronic signal dampening, computer programmable, compact size in a metal enclosure. Power input, 9-35 VDC/0-1 kHz, 75 ohms at 24 VDC, accuracy of 0.1% of full scale. Manufacturer: Kele Model 310-02, Universal Flow Transmitter Model UFT-1.

5. Liquid Leak Detection System: Kele, Raychem, Trace Tek.

   a. Mechanical float devices attached to or inserted within the auxiliary pan are not acceptable.

   b. Sensor shall be activated when there is at least ¼ inch of water, but no more than ½ inch of water in the auxiliary pan.

   c. Equal to Kele Model AQS00661 water detector.

E. HUMIDITY TRANSMITTERS

1. Units shall be suitable for duct, wall (room) or outdoor mounting. Unit shall be two-wire transmitter utilizing bulk polymer resistance change or thin film capacitance change humidity sensor. Unit shall produce linear continuous output of 4-20 mA for percent relative humidity (%RH). A combination temperature and humidity sensor may be used for zone level monitoring. Sensors shall have the following minimum performance and application criteria:

   a. Input Range: 0 – 100% RH

b. Accuracy (%RH): +/- 2% (when used for enthalpy calculation, dewpoint calculation or humidifier control) or +/- 3% (monitoring only) between 20-90%RH at 77°F, including hysteresis, linearity, and repeatability.

c. Sensor Operating Range: As required by application.

d. Long Term Stability: Less than 1% drift per year.

2. Acceptable Manufacturers: Units shall be Vaisala HM Series, General Eastern, Microline, or Hy-Cal HT Series.

2.6 CONTROL VALVES

A. Valves shall be rated for a minimum of 150 percent (150%) of system operating pressure at the valve location but not less than 125 psig.

B. 2" and Smaller: Valves shall be bronze body with screwed or flared connections.

C. 2-1/2" and Larger: Valves shall be bronze or iron body, flanged.

D. Flow characteristics:

1. Three-way valves shall have a linear relation of flow vs. valve position.

2. Two-way valve position vs. flow relation shall be equal percentage for water flow control.

E. Maximum pressure drop through valve:

1. Modulating water flow control: 1/2 the pressure drop through the apparatus with maximum of 10 feet of water. Two position water valves shall be line size.

2.7 CONTROL DAMPERS

A. The ATC Sub-contractor shall furnish all the controlled dampers of the type and sizes indicated on the drawings for installation by the sheet metal Sub-contractor.

B. All 2-position control dampers shall be parallel blade and sized for minimum pressure drop, at the specified duct size.

C. All modulating dampers shall be opposed blade and sized for an effective linear air flow control characteristics within the angle of rotation and maximum pressure drops specified. Information shall be provided to the sheet metal Subcontractor for determining the proper duct reductions or baffles used.

D. Damper frames shall not be less than 16-gauge galvanized steel, formed with corner braces for extra strength, with mounting holes for enclosed duct mounting.

E. All damper blades shall be of not less than 16-gauge galvanized steel formed for strength and high velocity performance. Blades on all dampers must not be over 8" in width. Blades shall be secured to 1/2" diameter zinc plated axles by zinc plated bolts and nuts. All blade bearings shall be nylon or oilite. Blade side edges shall be sealed off against spring stainless steel seals. Teflon coated thrust bearings shall be provided at each end of every blade to minimize torque requirements and insure smooth operation. All blade leakage hardware shall be constructed of corrosion resistant, zinc plated steel and brass.

F. Dampers shall be suitable for operation between -40 and 200 degrees. The control manufacturer shall submit leakage and flow characteristics plus a size schedule for all controlled dampers.

G. All blade edges shall have inflatable seal edging that shall be rated for leakage less than 10 cubic feet per minute per square foot of damper area at a differential pressure of 4" of water when the damper is being held by a torque not to exceed 50 inert lbs. Leakage shall not exceed 1/2 of 1% of total flow.

H. Provide permanent mark or scribe end of drive shaft to align damper with actuator in closed position.

2.8 CONTROL CABINETS

A. Control cabinets shall be constructed of 18-gauge steel with locking hinged door. Unless otherwise specified, all controllers, electric relays, switches and other equipment furnished as part of the control system which are not required to be mounted on mechanical equipment, shall be cabinet mounted. The temperature indicators and switches shall be flush mounted on the door tagged with plastic labels. All electrical devices shall be wired to a numbered terminal strip and all devices shall be completely adjusted and checked for proper operation prior to shipment to job site. All wiring shall be numbered according to the control diagram.

2.9 SEQUENCE OF OPERATION

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

1. The host computer and accessories shall be located 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.

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-1 and B-2, each with boiler circulating pumps BP-1 and BP-2, primary loop isolation valves, and building dual temperature heating/cooling pumps P-3 and P-4. 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-1 shall be enabled and B-2 shall be on standby. On a call for boiler B-1 to operate the isolation valve shall be commanded open, on a proof of open via valve end switch the boiler shall be enabled. B-2 shall remain in standby. If boiler B-1 cannot maintain hot water supply setpoint boiler B-2 shall be enabled to operate. The boilers master controller shall stage the boilers to maintain optimum efficiency and hot water supply temperature at setpoint.

3. Boiler Control Panel:

   a. The boiler control panel shall provide complete boiler modulation, boiler pump operation, operating control, diagnostics and multiple boiler lead/lag control.

   b. Panel 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 circulating pump and Pump BP-1 or BP-2 are activated, and the boiler isolation valves shall open (proven). A current sensor on one phase of power feeding the 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.

5. The building system loop temperature sensor shall control the boilers to provide the building loop heating water reset schedule based on outdoor air temperature.

6. 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 heating pump and lead boiler to provide heat until the setback space temperature is satisfied. If there is no call for heat after two hours (adjustable), the lead pump and boiler shall be de-activated and return to the off or standby status as scheduled.

7. Provide hot water discharge and return temperature sensors for each boiler.

8. BAS Contractor shall provide all field control wiring for control panels, combustion controls, header temperature sensors, and boiler master controller.

9. 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.

10. 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 C/T.
    i. Status of each isolation valve: open/closed.

C. Primary Dual Temperature Heating/Cooling Water Pumps Control:

1. Pumps P-3 and P-4 shall be controlled directly by the BAS per a lead/lag sequence with the designated lead pump alternated on a minimum weekly basis with the boiler (noted above), or as reset at the OWS. The designated lead pump shall be activated as part of the heating hot water boiler system. The pumps shall also be subject to a manual command at the OWS.

2. A current sensor on one phase of power feeding the pumps shall monitor flow status 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-3 Lead - Pump P-4 Lag).
   d. Pump command start/stop.
   e. Commanded status of each pump via C/T.
   f. Flow status/alarm.

D. Chilled Water System Control:

1. This system consists of one (1) water-cooled water chiller, CH-1, dual temperature loop pumps P-3 and P-4, primary chiller pump P-2, and interconnecting piping and accessories. Pumps P-3 and P-4 shall be controlled directly by the BAS per a lead/lag sequence. The lead/lag status shall be automatically changed once a week or as reset manually at the OWS. The designated lag pump shall be activated whenever the lead pump fails to operate once activated.

   a. A current sensor on one phase of power feeding the pumps shall monitor flow status at the OWS.

   b. Once activated, the designated lead pump shall run continuously. If the lead pump fails, after a 20 second time-delay, an alarm is sent to the OWS and the lag pump activated. After the cause of the failure is corrected, a manual command from the OWS is required to restore normal operation.

   c. The designated lead pump shall be activated automatically whenever the chiller is activated.

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 lead chilled water pump and condenser water pump shall be energized. When water flow is proven through each pump, via a current sensor, the chiller's factory controller shall be activated to maintain its integral setpoint of 42°F, adjustable.

   a. Chiller controller shall activate factory installed heat tape on the evaporator shell 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's setpoint upwards. The BAS shall provide an analog signal (0-10 vdc or 4-20 ma) to the chiller to reset the chiller's 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 C/T.
   g. Chilled water pump flow/alarm per pump via C/T switch.
   h. Condenser water pump start/stop command and status via C/T.
   i. Condenser water pump flow/alarm per pump via C/T switch.
   j. Chiller on/off command.
   k. Heat tape status.

E. Closed Circuit Fluid Cooler Control:

1. This system consists of a two cell, closed-circuit fluid cooler, CT-1A and CT-1B, and interconnecting piping.

   a. Interface with controls furnished with each fluid cooler for operation of the fan motor, fan motor VFD, spray water pump, basin level controller, and basin sump heater.

2. Upon a rise in condenser water return temperature, the tower fan motors shall be energized and ramp up in unison from minimum to full speed as required to maintain 85°F setpoint temperature leaving the towers. If the tower fans are at full speed and the tower leaving water temperature continues to rise, the spray water pumps shall be energized to maintain setpoint. The reverse shall occur on a fall in cooling tower loop temperature.

3. Provide a current sensor on one phase of power feeding the tower spray pump for monitoring and alarm generation. When current is not established after a delay of twenty seconds, adjustable, on a call for the pump to operate, an alarm shall be activated to the system.

4. Provide a water temperature sensor in the cooling tower sump for monitoring and alarm generation to the system. On a fall in sump temperature below the low limit setpoint of 40°F, adjustable, activate the basin sump heaters to maintain water temperature above freezing. On a continued drop in sump water temperature, provide an alarm to the system.

5. Monitor “voltage available” to the heat trace circuits on all exterior cooling tower makeup water to the cooling towers. Provide an alarm to the system if the outside air temperature is below 35°F, adjustable, and voltage is not available to the heat trace circuits. Coordinate with heat trace system provided as part of the work of Division 26 – Electric.

6. Provide water inlet and outlet water temperature sensors. Sensors shall be used to monitor and control the loop temperatures, and high/low temperature alarms.

7. Provide control wiring for the sump thermostat, low water cut off, and sump heater contactor furnished with the fluid cooler. Power wiring shall be provided as part of the work of Division 26 – Electric.

8. If the condenser loop temperature rises above 95°F, adjustable, at the pump discharge of pump P-1, an alarm shall be activated to the system.

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

   a. Outside air temperature and humidity.
   b. Condenser temperature entering and leaving each fluid cooler.

c. Condenser temperature high/low temperature alarms.
d. Sump temperature and low temperature alarm.
e. Fans status via VFD alarm/status contact and frequency feedback signal.
f. Heat trace circuit voltage status/alarm.
g. Spray pumps status via current sensor: on/off/alarm.
h. Diagram showing the layout of the equipment with major components and dynamic temperatures shown where temperature sensors exist in the system.

F. Dual Temperature Isolation Valves

1. Furnish dual temperature isolation valves as shown on the drawings. During heating season the hot water isolation valves shall be open to the dual temperature piping and the chilled water isolation valves shall be closed. During cooling season the chilled water isolation valves shall be open and the hot water isolation valves shall be closed. Heating and cooling valves shall be commanded from separate and individual outputs. When switching between heating and cooling, implement an adjustable time delay initially set to 12 hours to allow the dual temperature loop to reach ambient temperature before mixing with primary systems.

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

a. Individual zones showing isolation control valves and commanded position.
b. Operator selection to set heating/cooling position of each isolation control valve of each zone.

G. Refrigerant Monitoring System RMS-1 Control:

1. This system consists of a refrigerant monitor and sensors mounted in the Mechanical Room C121. Provide all functions and the following interlocks.

2. Whenever the monitor goes into high-level alarm, shut down the domestic water heater(s). Close the normally open motor-operated gas valve in the supply pipe to the domestic water heater(s).

3. Activate alarm horn and strobe light at each door into MER C121. Provide horn reset switch at each door to allow the horn to be silenced, while strobe light continues to flash until the system is reset.

4. Activate exhaust fan EF-1 after motor operated exhaust damper is open subject to damper limit switch. Open outside air damper at OAI-1.

5. Exhaust fan shall continue to run until the monitoring system resets. Once reset, the exhaust fan shall stop, dampers shall close, and the strobe lights shall turn off.

6. Provide alarm and system status at the OWS with remote alarm call out through the building Fire Alarm System.

H. Domestic Water Heater System Control

1. The domestic water heater(s) shall be activated by its integral temperature controls.

a. Combustion air control consists of roof-mounted outside air intake OAI-2.

b. Provide motor-operated damper and actuator for control of outside air.

c. Provide temperature sensor in the flue outlet above each heater's flue damper. On a rise in flue temperature above 100°F, adjustable, open outside air damper fully.

d. If damper limit switch does not prove damper open, once activated, after a 20-second time delay, generate a "combustion air failure" alarm at the OWS. Heater shall continue to operate.

e. Once heater is off and its flue damper closes, maintain outside air damper open until flue temperature is below 100°F, adjustable; close damper fully.

f. Provide select relay to interface sensors in each flue for both water heaters so that damper opens on a first call for heat and stays open until the last unit to fire shuts down.

2. Provide a hot water discharge sensor for monitoring, high/low limit alarms for the heater and for each 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 of the two, domestic hot water circulating pumps based on a schedule furnished by the Owner. Provide a differential pressure switch across each 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(s) activated/deactivated.
   b. Domestic hot water discharge temperature.
   c. High/Low discharge temperature alarm, heater(s) and each loop.
   d. General failure signal.
   e. Commanded status of domestic hot water circulator pumps.
   f. Pump flow status/failure alarm.

I. Energy Plant Mechanical Room C121 Heating and Ventilation System Control

1. This system consists of unit heaters UH-1 and UH-2, roof mounted exhaust fan EF-1, and outside air intake OAI-1. Provide motor operated dampers and actuators for control of exhaust and outside air in the room. Provide space temperature sensors 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 sensors shall energize the fans on the unit heaters to run in unison. On a rise in space temperature, the reverse shall occur.

4. Coordinate operation of EF-1 with paragraph G.

5. 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 fans.

J. Blower 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 a 24-volt control transformer and all sensors required for operation, monitoring, and control of each 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 sensor 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 sensor.
    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.

K. 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 sensor 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 sensor.
   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.

L. 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 sensor 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 sensor.

M. Zone Heating Duct Coil Control

1. Duct coils, DC-1 through DC-6, 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.

N. Hydronic Fintube Radiation Control:

1. The hydronic fin tube radiation shall be controlled by a two-way, modulating 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.

O. Ductless Split System Unit Control:

1. The following sequence is typical for:

   a. AC-1 and ACC-1 which serves the IDF Room.
   b. AC-2 and ACC-2 which serves the MDF Room.
   c. AC-3 and ACC-3 which serves the Stage Storage Room.
   d. AC-4 and ACC-4 which serves the IDF Room.

2. Each unit shall be controlled by its factory controls. 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.

P. Kitchen Hood Exhaust Fan EF-2 & Make-Up Air Unit MAU-1 Control

1. The hood exhaust fan and make-up air unit shall be energized automatically by temperature sensor(s) provided as part of the hood. Interface with these sensor(s) in accordance with hood manufacturer's written instructions.

2. The kitchen equipment manufacturer shall provide the BAS Contractor with wiring diagrams for the hood.

3. The following items shall be provided by the make-up air unit manufacturer:

   a. Motor starters and overload protection.
   b. Outside air damper and actuator.
   c. Terminal blocks for all wiring connections between equipment and control devices.

4. Provide a current sensor 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. 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.

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

6. The system shall prevent the circulation of smoke. Upon activation of the duct smoke detector in the supply air duct at the discharge of MAU-1, the unit shall stop and all dampers shall close.

   a. The Mechanical Contractor shall install duct smoke detector furnished as part of the work of Division 26 – Electric.

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.

    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. MAU-1 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 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 sensor.
    g. Exhaust fan operational status via current sensor.
    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.

Q.1 Exhaust Fan EF-3, EF-4 and EF-5 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.

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 sensor on one phase of power feeding the fan for status indication at the OWS. Provide an alarm if the fan is commanded on and flow is not proven after a 20-second delay.

5. 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.

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

    a. Fan status via current sensor: on/off/alarm.
    b. Commanded status of fan and damper.

Q.2 Exhaust Fan EF-1 Control

1. 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. Fan shall run continuously during the occupied mode for the kitchen dishwasher area. Set schedule in accordance with Owner's requirements.

3. Provide a current sensor on one phase of power feeding the fan for status indication at the OWS. Provide an alarm if the fan is commanded on and flow is not proven after a 20-second delay.

4. 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.

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

   a. Fan status via current sensor: on/off/alarm.
   b. Commanded status of fan and damper.

Q.3 Exhaust Fan EF-6 and EF-7 Control

1. Interface each fan with the toilet room light switch.

2. Whenever the room light switch is activated manually, the fan shall run.

3. When the light switch is turned off, the fan shall stop.

R. Energy Recovery Unit Control

1. The following sequence is typical for units ERU-1 through ERU-4. Each unit consists of supply fan, exhaust fan, packaged DX cooling system with hot gas reheat, 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 furnished with the unit. The DDC Controller shall be wired to 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 BAS Contractor shall furnish required sensing and control devices to the unit manufacturer for factory installation and wiring. 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.

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 shall modulate to maintain the minimum discharge air temperature setpoint of 70degrees F, adjustable. On a rise in discharge air temperature, the DX cooling system shall be staged to provide cooling. On a fall in temperature the reverse shall occur.

   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.

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 sensor.
   h. Exhaust fan operational status via a current sensor.
   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.

S.1 Packaged Rooftop Unit Control: General

1. The sequence that follows is typical for units RTU-2 through RTU-5. 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.

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 all unit functions.

   The following items shall be provided by ATC.

   a. Discharge air temperature sensor.
   b. Return air temperature and humidity sensors.
   c. Global outside air temperature and humidity sensors.
   d. Current sensor for one phase of the power feeding the fan.
   e. Mixed air average temperature sensor.
   f. CO2 sensors and space temperature sensors.
   g. 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 sensor 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.

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 sensor.

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

S.2 Packaged Rooftop Unit Control: Cafeteria

1. This system consists of a packaged rooftop unit RTU-1 which is equipped with fan, air-cooled DX system, gas-fired heating section, filters, and an outside air energy recovery ventilation module, ERM-1, with fans, dampers, and desiccant wheel. The system shall operate as a constant volume system with minimum outside air, CO2 control, and economizer mode of operation.

   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 CO2 sensor in the return air duct at the unit.

   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 damper shall close, the return air damper shall open, the energy recovery module shall stop, and the supply fan 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, 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.

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 degrees F, adjustable, or to cooling setpoint of 75°F, adjustable. Outside air damper shall remain closed, return air damper open, and energy recovery module off.

4. Outside air damper shall remain closed until return air CO2 level rises to 700 ppm. The outside air damper shall open and the energy recovery module fans and desiccant wheel shall start. The return air and relief air dampers in the system shall modulate in unison to maintain the balance of air in the system.

   a. Low ambient controls in the energy recovery module shall monitor the air temperature leaving the exhaust side of the energy wheel. Whenever it drops below the field adjusted setpoint, the outside air motor operated damper shall close, intake fan shall stop, exhaust fan shall continue to run, and the energy wheel shall continue to run. When the temperature sensor has a sixteen-degree rise, the energy wheel is defrosted and the outside air damper shall open, intake fan start, and normal operation shall continue.

5. On a call for cooling, the controller shall activate the DX cooling section through its unit controls to maintain scheduled leaving air temperature. During the occupied mode, the supply fan shall be energized. The outside air energy recovery module shall activate as described in item 4.

   a. The economizer sequence shall be activated upon a call for the first stage of cooling. When outdoor air, as sensed by the global outside air temperature and humidity sensor is 25 BTU/lb, adjustable, the energy recovery module shall be de-activated for a minimum period of two minutes. The motor operated outside air damper shall close.

   b. Onboard controls shall move the energy recovery wheel out of the air stream and bypass dampers along both sides of the intake fan shall open fully.

c. Once the wheel and dampers are in position, the motor operated outside air damper shall open fully, exhaust fan shall be activated to provide full relief capacity for economizer operation. The supply fan in the energy recovery module shall remain off.

d. When outside air can no longer maintain conditions for free cooling, the reverse sequence shall occur, and the system shall revert to DX cooling as described in item 5.

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. Mixed air temperature.
   b. Mixed air temperature setpoint.
   c. Outside air and return air temperatures.
   d. Fire alarm system status/alarm.
   e. Commanded status of fan.
   f. Supply fan operational status via current sensor.
   g. Fan drive status via frequency feedback on fan VFD.
   h. CO2 level/high limit alarm.
   i. Unit discharge air temperature.
   j. Diagram showing the layout of the equipment with major components and dynamic temperatures shown where temperature sensors exist in the system.

T. 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.

U. 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. 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.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install system and materials in accordance with manufacturer's instructions and roughing-in drawings, and details and drawings. Install electrical work and use electrical products complying with requirements of these specifications. Mount controllers at convenient locations and heights.

B. All wiring shall be properly supported and run in a neat and workmanlike manner. All wiring exposed and in equipment rooms shall run parallel to or at right angles to the building structure. All wiring within enclosures shall be neatly bundled and anchored to prevent obstruction to devices and terminals. All wiring shall be in accordance with all local and national codes. Low voltage wiring for space temperature sensors, communication bus between terminal units, etc., above accessible ceilings in finished spaces on the floors may be plenum rated cable. Wiring in all other locations shall be installed in EMT conduit. All electronic wiring shall be #18 AWG minimum THHN and shielded if required, except standard network (Ethernet, LonWorks, etc.) cabling shall be as tested and recommended in lieu of #18 gauge twisted, #22 or #24 gauge is acceptable if used as a part of an engineered structured cabling system. The control manufacturer must submit technical and application documentation demonstrating that this cabling system has been tested and approved for use by the manufacturer of both the control system and the engineered structured cabling system.

C. Provide all sensing, control, and interlock wiring for the following:

System inputs and outputs
System communications
System power
System interlocks
Unit controls

D. The Control Manufacturer shall enter all computer data into the Host computer including all graphics, control programs, initial approved parameters and settings, and English descriptors. The Control Manufacturer shall maintain diskette copies of all data file and application software for reload use in the event of a system crash or memory failure. One copy shall be delivered to the owner during training sessions, and one copy shall be archived in the Control Manufacturer's local software vault.

3.2 DATA CONTROL (D/C) AND GRAPHICS SUMMARY

A. All hardware, custom software, application software, graphics, etc., necessary to accomplish the control sequences and display the graphics specified shall be provided as part of this contract. Provide all controllers, inputs, outputs, valves, dampers, actuators and flow meters required to provide the control and graphic data described. Provide software setpoints required for display in logical groups and graphics.

B. Each digital output shall have a software-associated monitored input. Any time the monitored input does not track its associated command output within a programmable time interval, a "command failed" alarm shall be reported.

C. Where calculated points (such as CFM) are shown, they shall appear in their respective logical groups.

D. Unless otherwise specified or approved prior to bidding, the primary analog input and the analog output of each DDC loop shall be resident in a single remote panel containing the DDC algorithm, and shall function independent of any primary or UC communication links. Secondary (reset type) analog inputs may be received from the primary network, but approved default values and/or procedures shall be substituted in the DDC algorithm for this secondary input if network communications fail or if the secondary input becomes erroneous or invalid.

3.3 ACCEPTANCE

A. The Control Manufacturer shall completely check out, calibrate and test all connected hardware and software to ensure that the system performs in accordance with the approved specifications and sequences of operations approved.

B. Witnessed acceptance demonstration shall display and demonstrate each type of data entry to show site specific customizing capability; demonstrate parameter changes; execute digital and analog commands; and demonstrate DDC loop stability via trend of inputs and outputs.

3.4 MANUALS

A. The following manuals will be provided:

1. An Operators Manual shall be provided with graphic explanations of keyboard use for all operator functions specified under Operator Training.

B. Computerized printouts of all GPC data file including all point processing assignments, physical terminal relationships, scales and offsets, command and alarm limits, etc.

C. A manual shall be provided including revised as-built documents of all materials required under the paragraph "SUBMITTALS" on this specification.

D. Two Operators Manuals, and two As-Built Manuals shall be provided to the owner.

3.5 TRAINING

A. All training shall be by the BMCS contractor and shall utilize operator's manuals and as-built documentation.

B. Operator training shall include three (3) four-hour sessions encompassing modifying text and graphics, sequence of operation review, selection of all displays and reports, use of all specified OWS functions, troubleshooting of sensors (determining bad sensors), and password assignment and modification. One training session shall be conducted at system completion, one shall be conducted forty-five days after system completion, and one at ninety (90) days, or as requested by the Owner.

3.6 SERVICE GUARANTEE

A . The control system herein specified shall be free from defects in workmanship and material under normal use and service. After completion of the installation, the control manufacturer shall regulate and adjust all thermostats, control valves, motors and other equipment provided under this contract. If within twelve (12) months from date of acceptance either for beneficial use of final acceptance, whichever is earlier, any of the equipment herein described is proven to be defective in workmanship or materials, it will be replaced or repaired free of charge. The control manufacturer shall, after acceptance, provide any service incidental to the proper performance of the control system under guarantee outlined above for the period of one year. Normal maintenance of the system or adjustments of components is not to be considered part of the guarantee. The control manufacturer will upon completion of the installation, during the warranty period, make available to the Owner, an annual service agreement covering all labor and material required to efficiently maintain the control system.

3.7 FINAL ADJUSTMENT

A. After completion of installation, adjust thermostats, control valves, motors and similar equipment provided as work of this section.

B. Final adjustment shall be performed by specially trained personnel in direct employ of installer of primary temperature control system.

END OF SECTION 230900

SECTION 230950: 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, chilled water and condenser water systems. The balancing agency shall perform the following tests, compile data and submit reports.

2. Pumps:

a. Design Data

(1) GPM, head
(2) RPM, BHP

b. Installed Equipment

(1) Manufacturer, Size
(2) Type Drive
(3) Motor HP, Volts, Cycles and Phase
(4) Full Load Amperes

c. Field Test

(1) Discharge Pressures: Full flow & no flow
(2) Suction Pressures: Full flow & no flow
(3) Operating Head and GPM
(4) No Load Amperes (where possible)
(5) Full Flow Amperes, No Flow Amperes
(6) Calculated BHP

3. Heating and/or Cooling Elements Including Loop Water to all terminal Units:

a. Design Data:
(1) MBH Specified, GPM Specified
(2) Entering Water Temperature (EWT)
(3) Entering Air Temperature (EAT)
(4) Water Temperature Drop (DTW)
(5) Element Type Specified

b. Field Test:
   (1) Identify each element as to location
   (2) Required water temperature drop corrected for item (3) above
   (3) Actual entering air and water conditions (temperature and GPM)
   (4) Adjust element until required temperature drop is obtained

C. In addition to the above work, the Balancing Firm shall check the operation of all automatic temperature control equipment; verify all thermostat, aquastat, etc., set-points and operations; and enlist the aid of the Mechanical Contractor and the Control Subcontractor to make necessary adjustments where required.

END OF SECTION 230950

SECTION 260000 – 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.

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/Audio Visual
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 92) 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:

- Security System
- Fire Alarm System
- Integrated Access Control
- Clock and Speaker System
- VFD’s
- MDF/IDF
- Stage Sound System
- Stage Dimming Rack

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, or ACI-613. Designer choice if 03300 is not used.

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.

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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 one year 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 260000

SECTION 260055: 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. Fire Alarm Master Station and Annunciator.
5. Paging and Intercommunication Systems
6. 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 260055

SECTION 260110: 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

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.

3. Interior Use Only:

   a. Raceways: Shall be multi-cell raceway system for use inside building applications. 10 ft. length sections of 4” electrical metallic tubing 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. MESS4S-010.

   b. 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.

4. Subject to compliance with requirements, provide products of the following:

   Carlon Electrical Products.

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

I. 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, where indicated on the floor plans surface raceway shall be installed. Should it be impossible or impracticable to install a raceway concealed and surface raceway is not indicated, the Contractor shall consult with the Architect or Engineer for approval prior to installation.

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 260110

SECTION 260120: 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. Arrange for and coordinate with the Utility Company and pay any and all costs in conjunction with the 25KV primary service from the point of connection to 25KV pad-mounted transformer.

C. Types of wire, cable and connectors in this section include, but not limited to the following:

Copper conductors.
Tap type connectors.
Split-bolt connectors.

D. Refer to other sections of Division 26 for, but not limited to, raceways, connections used in conjunction with wire and cable work.

E. 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.

<u>Connectors</u>
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: AC (Armor Clad)
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 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 aluminum cable as approved by the Utility Company in quantities required by the Utility Company.

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 with the Utility Company.

D. Deliver 25KV cable terminations to the Utility Company for installation and connection.

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 260120

SECTION 260135: 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.

C. Refer to Section 260140 – WIRING DEVICES for exterior receptacle outlet boxes.

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 260135

SECTION 260140: 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
Sensor Switch

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.

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.

E. All Isolated Ground Duplex Receptacles shall be extra heavy duty, 20 amperes, 125 volts, 2 pole, 3 wire isolated ground with metal plaster ears, isolated from ground circuit, side wiring, NEMA configuration 5-20R unless otherwise indicated. Devices shall be color coded with an orange face and black triangle to identify all isolated ground devices. Hubbell Cat. #IG5362, #IG8300R, or approved substitute.

F. All surge protection receptacles shall be extra heavy duty duplex, 20 amperes, 125 volts, 2 pole, 3 wire with built-in surge protection, metal plaster ears. Devices shall include efficient 3-level MOV protection for phase to neutral, phase to ground and neutral to ground. Devices shall also include diagnostic LED indicator light to be on continuously when protection is active, and shall flash on and off when protection circuit is deactivated due to excessive transients. Hubbell Cat. #HBL5362SA, or approved substitute.

G. All isolated ground, surge protection receptacles shall be extra heavy duty duplex, hospital grade, 20 amperes, 125 volts, 2 pole, 3 wire isolated ground with built-in surge protection with metal plaster ears isolated from ground circuit. Device shall include efficient 3-level MOV protection for phase to neutral, phase to ground and neutral to ground. Device shall also include diagnostic LED indicator light to be on continuously when protection is active, and shall flash on and off when protection circuit is deactivated due to excessive transients. Devices shall be blue with green dot and orange triangle, Hubbell Cat. #IG5362SA, #IG8362SA, or approved substitute.

1. Whether indicated or not on the floor plans, the Electrical Contractor shall furnish and install one (1) isolated ground, surge protective receptacle next to each data outlet and connect to isolated ground panelboard, unless directed otherwise.

2.4 USB CHARGING DEVICES

A. All USB charging devices shall be heavy duty, 5VDC, 4.2A charging capacity, 3-wire grounding, with green hexagonal equipment ground screw, with metal plaster ears, quadruple charging outlet ports, Hubbell Cat. #USB4, Pass and Seymour Cat. #TM8USB4XCC6 or approved substitute.

B. All USB charging devices with receptacles shall be extra heavy duty, hospital grade, 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, with teo charging outlet ports, 5VDC, 3.8 amp charging capacity, Hubbell Cat. #USB20X2, Pass & Seymour #TM8USB4XCC6, #USB8300 if hospital grade, or approved substitute.

2.5 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. Three Position Switch: Provide extra heavy duty industrial series, flush toggle, single pole, three position, momentary contact, center position OFF, AC quiet switch rated 20 amperes @ 120/277 volts, with green hexagonal equipment ground screw, metal plaster ears, and side-wired screw terminals. Similar to Hubbell Series HBL or approved substitute.

D. 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.

2.6 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. 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.

B. Weatherproof device plates shall have spring-hinged waterproof cap suitably configured for each application, including face plate gaskets and corrosion-resistant fasteners. Boxes and devices shall be recessed, weatherproof with smoke gray opaque in-use covers. Intermatic Cat. #WP1000(H)GRC.

C. Mechanical spaces where concealed work is impractical, such as masonry poured 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.

2.7 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.

2.8 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.

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 260140

SECTION 260155: 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.
Adjustable Frequency Drive (AFD)

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.

F. Adjustable Frequency Drive (AFD): The AFD shall convert the input AC main power to an adjustable frequency and voltage. The output frequency and voltage of the AFD shall be adjustable to maintain a constant voltage/hertz ratio throughout the operating range. The AFD shall be designed to operate from a 480 volt, three phase, 60 hertz main supply that is within +10% or -10% of nominal line voltage. The AFD control technique shall employ the pulse width modulated (PWM) technology.

1. Ratings:

   a. The AFD shall be capable of supplying 120% of rated full load current for one minute at maximum ambient temperature.

   b. Unit shall be rated for installation in a power system capable of delivering up to 65,000 RMS symmetrical amperes.

   c. Minimum power factor shall be .95 throughout the entire speed range.

   d. The AFD efficiency shall be 98% at full speed.

2. Adjustments:

a. The acceleration and deceleration ramp rates shall be adjustable from 1 to 60 seconds.

b. The overload trip shall be adjustable from 0 to 100% of rated output current.

c. The current limit shall be adjustable from 60 to 120% of rated output current to maximize starting torque.

d. Voltage boost shall be adjustable from 100 to 400% of nominal voltage/hertz ratio at 1 hertz tapering to 100% at 20 Hertz.

e. The drive shall provide a control for adjusting the minimum frequency setting up to 45 Hertz and a maximum operating frequency adjustable over a range of 40 to 60 Hertz.

3. Protection:

a. A non-adjustable instantaneous overcurrent trip shall be set to 250% of rated output current.

b. AFD protection shall be accomplished with fuseless electronic protective circuits, to protect from the following conditions:

- Short circuit at AFD output.
- Ground fault at AFD output.
- Open circuit at AFD output.
- Input undervoltage.
- DC bus overvoltage.
- Loss of input phase.
- AC line switching transients.
- Instantaneous overload.
- Sustained overload exceeding 100% of rated current.
- Overtemperature.

4. Control:

a. All the following operator controls shall be mounted to the front panel which is integral to the AFD:

- Manual speed potentiometer.
- Hand-Off-Auto (HOA) switch. The AFD shall accept an input signal of 4 to 20 Ma. DC. as an automatic speed reference signal when the AFD is in the automatic mode of operation. The manual speed potentiometer shall control the AFD when the switch is in the manual mode.
- The AFD shall be furnished with an isolated follower with a setpoint control of 4 to 20 Ma. DC with PI control from an isolated ground signal.

5. Operator Interface:

a. The AFD shall be furnished with an alphanumeric display and keypad to allow the operator access to drive modes, parameters and status conditions.

b. Operator control and setup functions shall include the following:

(1) Frequency setpoint
(2) Acceleration/Deceleration time
(3) Minimum/Maximum Output Frequencies
(4) Proportional Gain
(5) Integral Gain
(6) Setpoint
(7) Drive Reset
(8) Elapsed Time
(9) Enable PI (Setpoint) Control
(10) Auto Reference Source Select

Operating status information will consist of the following:

(1) Frequency Output
(2) Output Current
(3) Output Voltage
(4) Accel/Decel Ramp Time
(5) Forward/Reverse Direction
(6) Hand/Auto Local Indicator
(7) Elapsed Time

The diagnostic and fault conditions available via the operator interface will include the following:

(1) Output Frequency
(2) Output Current
(3) Output Voltage
(4) Shutdown Reference Status
(5) Jog Status
(6) Mode of Operation
(7) Input Signal Levels
(8) Faults
(9) Overload Timer Activated
(10)Motor Current Limit

6. Enclosure:

a. The enclosure shall be NEMA Type 1 with a dead front and back construction with all components and load, line and control terminations fully front accessible. The enclosure shall be self-ventilated and have provisions for top and bottom entry of conduit and wire.

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.

D. When packaged equipment is furnished, all unit starters shall be furnished, mounted and wired by the installing contractor. The Electrical Contractor shall furnish and install a disconnect switch, as specified in Section 260170, and wire between unit's main terminal block and the disconnect switch.

E. When packaged rooftop equipment is furnished, the unit disconnect switch and all starters shall be furnished, mounted and wired by the installing contractor. The Electrical Contractor shall wire between the line side of the disconnect switch and the building system.

F. Should the Electrical Contractor elect to furnish and install an electric alternator with magnetic starters in lieu of the duplex motor controller, he shall provide all control wiring needed to make the alternator and the starters function as a unit.

G. Provide connections for motor starters.

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 260155

SECTION 260160: 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.
Electronic Grade 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.

D. Split Bus Panelboards: Provide dead-front safety type split bus panelboards as indicated in contract documents; switching and protective devices in quantities, ratings, types shown; with anti-turn solderless pressure type lug connectors approved for copper conductors; construct unit for connecting feeders; equip with aluminum bus bars, aluminum full-sized neutral bar, equipment ground bus, with bolt-on molded-case thermal magnetic circuit breaker types for each circuit, with toggle handles that indicate when tripped; where multiple pole breakers are indicated, provide with common trip so overload on one pole will trip all poles simultaneously, and provide panelboards fabricated by same manufacturer as enclosures, and which mate properly with enclosures. Provide in panel mechanically held magnetic contactors with coil clearing contacts suitable for service indicated of sizes and ratings shown.

E. Electronic Grade Panelboard: Furnish a dead-front safety type panelboard with the following:

1. 42 poles with size, type and number of circuit breakers as indicated on the floor plan.
2. Isolated ground bus.
3. 200% rated copper neutral bus.
4. Equipment ground bus.
5. Integral transient voltage surge suppressor.
6. High frequency extended range tracking filter and high performance suppression system.
7. Full diagnostic test point.

F. TVSS Requirements:

1. TVSS shall be Listed in accordance with UL 1283 and 1449 Second Edition, including the highest fault current of Section 37.3. (UL Recognized for Integral.)

2. TVSS shall have a UL Listed Short Circuit Current Rating (SCCR), equal to or greater than the SCCR where connected, per NEC 2002, Article 285 (as noted on drawings). It shall not require the use of any upstream overcurrent protection to obtain said rating.

3. TVSS shall be marked, *Suitable for use on a Circuit Capable of Delivering Not More Than ____ rms symmetrical Amperes, ____ Volts Maximum.* This marking shall be equal to or greater than the available fault current and voltage of application.

4. TVSS suppression components shall have a maximum continuous operating voltage (MCOV) of not less than 115% of the nominal phase-to-neutral operating voltage.

5. TVSS Submittal information shall include UL 1449, 2nd Edition, Listing Classification Page, indicating per mode Suppressed Voltage Ratings and UL Listed SCCR, each model and voltage.

6. Panel extended TVSS shall be installed, UL Listed, and shipped from the TVSS equipment manufacturer's factory using a UL recognized component listing, or shall be installed by the contractor following field installation instructions for a UL Recognized TVSS in a panel extension, per the drawings.

7. TVSS shall provide surge current diversion paths for all modes of protection; L-N, L-G, N-G in WYE systems, and L-L, L-G in DELTA systems.

8. TVSS shall be modular in design for Distribution. Module(s) shall be fused with surge rated fuses and incorporate thermal cutout devices capable of preventing thermal runaway of internal suppression components.

9. TVSS shall be provided with 1 set of NO/NC dry contacts for connection with a facility management system, and provide an audible alarm for notification of reduced or lost protection.

Device shall have LED indicators to indicate the status of protection on each phase and/or mode.

10. TVSS shall meet or exceed the following criteria:

    a. Minimum per phase (L-N + L-G) surge capacity shall be (as noted on drawings):

       (1) Distribution panels: 160kA – High Exposure 120kA – Medium/Low
       (2) Branch panels: 120kA – High Exposure 80kA – Medium/Low

    b. UL 1449 Listed, and Recognized Component Suppressed Voltage Ratings shall not exceed the following:

VOLTAGE	L-N	L-G	N-G
208Y/120	400V	400V	400V
480Y/277	800V	800V	800V

11. TVSS shall have a minimum EMI/RFI filtering of -50dB at 100kHz.

12. TVSS shall be provided with 1 set of NO/NC dry contacts. (when specified)

13. TVSS shall be provided with surge counter, as noted on drawings. (when specified)

14. TVSS shall have a five-year warranty. Warranty shall be the responsibility of the electrical distribution equipment manufacturer and shall be supported by their respective field service division.

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 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.

E. Provide two discs to owner containing software and project panel directories and summaries.

END OF SECTION 260160

SECTION 260165: 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.

G. Main switchgear shall be furnished with a phase loss relay with a set of contacts to send a trouble alarm to existing security control panel. Unit shall be furnished, installed and wired by equipment manufacturer. All other wiring required for proper interface to security control panel shall be by the Electrical Contractor. Coordinate all work and provide all required wiring as directed by Owner's local security system representative.

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 260165

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. When packaged rooftop equipment is furnished, the unit disconnect switch shall be furnished, mounted and wired by the installing contractor.

D. When rooftop exhaust fans rated less than 1/2 HP at 120 volts, single phase, are furnished, except utility sets, the unit disconnect switch shall be furnished, mounted and wired by the installing contractor.

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 260170

SECTION 260180: 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 260180

SECTION 260190: 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 260190

SECTION 260195: 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 installed in the new Courthouse building (Bid Pac B) to <u>all</u> downstream distribution and branch panelboards (including new and those installed under Bid Pac B); and from generator to <u>all</u> emergency distribution and transfer switches (including new and those installed under Bid Pac B).

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 Delmarva Power.

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 260195

SECTION 260430: 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 260430

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.

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 260452

SECTION 260460: 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

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):

<u>Dry</u>

Sorgel Electric Division/Square D Company
Cutler-Hammer/Eaton Electrical, Inc.
The ABB Group
Siemens Energy & Automation, Inc.
Mirus International, Inc.
Approved Substitute.

2.2 POWER/DISTRIBUTION TRANSFORMERS

A. General Requirements:

1. Except as otherwise indicated, provide manufacturer's standard materials and components as indicated in contract documents and by published product information designed and constructed as recommended by manufacturer, and as required for complete installation.

2. All 3-phase transformers sized from 15 Kva thru 750 Kva shall be Energy Star rated and be compliant with NEMA Standard TP-1.

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 be aluminum wound windings, 220°C Class insulation and temperature rise rating of 150 degrees C. Unit shall be provided with six (6) approximately 2-1/2% taps, two (2) above and four (4) below rated primary voltage. A low voltage neutral terminal shall be provided. Coils shall be enclosed by a sheet steel enclosure comprised of readily removable sections having ventilated openings in front cover. Core and coil assemblies shall be mounted on rubber isolation pads. Limit terminal compartment to 75 degrees C. at full-rated load. Provide wiring connectors suitable for copper wiring. Cushion-mount transformers with external vibration isolation supports. Electrically ground core and coils to transformer enclosure by means of flexible metal grounding strap.

2.3 HARMONIC MITIGATING ISOLATION TRANSFORMERS: (T-3)

A. Furnish an isolation transformer with low zero sequence output impedance designed to reduce the voltage distortion created by the 3rd and other triplen harmonic currents. Primary-secondary phase shift permits cancellation of 5th, 7th, 17th and 19th harmonic currents with those of other loads fed from the same primary supply. Transformer shall be Energy Star rated and be compliant with NEMA Standard TP-1.

B. Furnish an open ventilated, three (3) phase, common core unit with copper windings. Unit voltage and KVA rating shall be as indicated on the floor plans and/or single line diagram. Transformers shall have a insulation class 220 degrees C. and a temperature rise rating of 80 degrees C. Unit shall be furnished with a full load efficiency of 97% minimum at 170 degrees C. and two (2) full load taps above normal and two (2) full load taps below normal. Transformer shall have single electrostatic shielding rated 60dB attenuation.

C. Enclosure shall be an open ventilated, NEMA-1, general purpose, finished in grey with anti-vibration pads between the core and the enclosure.

D. Transformer shall be similar to Mirus International, Inc., Model Harmoney-1, 2 or 3, based on the quantity of feeder taps or approved equal.

PART 3 – EXECUTION

3.1 INSTALLATION OF TRANSFORMERS

A. Install transformers as indicated in contract documents, and 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 260460

SECTION 260470: 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 260470

SECTION 260471: 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 260471

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.

D. Convenience Circuit Dedicated with Isolated Ground: A circuit consisting of a phase, neutral and ground 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.

1. The isolated ground conductor shall be connected to an isolated ground type receptacle as described under the Wiring Devices Section of the specifications.

2. The isolated ground conductor shall be identified by green insulation with a yellow stripe.

3. The isolated ground conductor shall be connected to an isolated ground bar in the branch circuit panelboard. This isolated ground bar shall then be connected to an applicable derived system ground or service entrance ground.

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 260472

SECTION 260475: 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 200 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 5 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,1 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-5 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 260475

SECTION 260510: 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 260510

SECTION 260520: 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 260520

SECTION 260601: 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.

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 260601

SECTION 260731: 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] [enabled with Power over Ethernet (PoE) 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 [ac-power] [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 SUBSTITUTIONS

A. Proposed substitutions, to be considered, shall be manufactured of equivalent materials that meet or exceed specified requirements of this Section.

B. Proposed substitutions shall be identified not less than 10 days prior to bid date.

1.9 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.

1.10 DELIVERY STORAGE AND HANDLING

A. Deliver all components to the site in the Manufacturer original packaging.

B. Packaging shall contain Manufacturer name and address, product identification number, and other related information.

C. Store equipment in finished building and in unopened packaging until ready for installation.

1.11 PROJECT SITE CONDITIONS

A. 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.

1.12 WARRANTY

A. Manufacturer shall provide a one 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.

1.13 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 27 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.

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.

END OF SECTION 230731

SECTION 260771: INTERCOM/TELECOMMUNICATION AND CLOCK SYSTEM

PART 1 – GENERAL

1.1 General

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

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 – Odessa Campus Project.

1.2 Scope of Work

A. Provide a telephone type communications system for all instructional and administrative areas. Provide for system integration of the following basic school communications systems including the Cafetorium and local classroom sound systems.

1. Telephone System
2. Voice Mail System
3. Intercom/Public Address System
4. Remove wired and add Primex Wireless-Tone Generator Ant. With cable to roof.

B. Digital 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. Single line telephones with message lamps.
7. Software programmable features, functions, and restrictions.

C. Voice Mail System: Provide system that utilizes recorded voice messages that are accessible from any touch tone telephone. System shall be fully integrated to digital telephone system. System shall provide the following features and functions.

1. Ability to light and extinguish message lights automatically.
2. Homework Hotline
3. Outbound Dialing
4. Parent Messages
5. School-Wide Announcements
6. Automated Attendant
7. 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.

E. Master Clock/Program: System includes the master clock, clocks and tone generator to provide the classroom time and schedule signaling. System interconnects with the paging system to provide for distribution of class change tones.

1. Master clock controller.
2. Synchronous analog clocks.
3. Selective tone signal distribution.
4. Utilizes paging speakers for audible signal distribution.

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.

E. Voice Mail / Homework Hotline: Basic training shall be provided for this system. Additional training for system programming and database management shall be in addition to this contract and will be purchased on an "as needed" basis.

1.6 Warranty and Maintenance

A. Provide a one (1) year warranty of the installed system against defects in material and workmanship. All labor and materials shall be provided at no expense to the Owner during normal working hours. The warranty period shall begin on the date of system acceptance.

B. Make available a service contract offering continuing factory authorized service of this system after the initial warranty period.

1.7 Quality Assurance

A. Maintenance Qualifications:

1. Experienced in manufacturing equipment of the types and capacities specified for this project.
2. Equipment has a record of successful in-service performance.

B. Contractor Qualifications:

1. Established communications and electronics contractor for at least five (5) years.
2. Authorized distributor for the equipment supplied with full manufacturer's warranty privileges.
3. Maintains a fully equipped service organization capable of providing full maintenance and service of the installed system within 24 hours.
4. Maintains the necessary spare parts in the proper proportion as recommended by the manufacturer to maintain and service the equipment being installed.

C. Manufacturer's Instructions: Comply with all installation instructions and methods recommended or required by the manufacturer.

D. Reference Standards: Comply with all reference standards indicated in this section as applicable. System shall be UL Listed under UL813.

1.8 System Requirements and Operation

Digital Telephone System

A. The contractor shall provide a complete and satisfactory digital telephone system. All equipment and installation material requirements shall be furnished and installed including the interfaces to intercom and voice mail systems. System being provided is a Remote Campus ECS. The ECC Building will be connected to the Elementary School via fiber.

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 attendants 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).

<u>VOICE MAIL SYSTEM</u>: 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.

l0. 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 (I) 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. Equipment manufactured by manufacturers as listed herein is considered approved for bidding on this project. Where specific makes and models are referred to, the intention is to establish a minimum level of performance and features. Equipment of another manufacturer may be substituted provided is it suitable for the application and meets or exceeds the specified performance in all areas. Approvals for installation shall be subject to review and approval by the Engineer. The contractor shall be prepared to supply the specified equipment if the proposed equipment is judged to be not acceptable.

B. All bids shall be based on the equipment as specified herein.

C. 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:

I. Simplex Building Systems

2.2 EQUIPMENT

A. PBX Telephone System

1. Simplex 5195 ADIX System

C. Intercom/Public Address System

1. Simplex 5120 Integrated Communication System

2.3 PBX TELEPHONE SYSTEM

A. Telephone Instruments:

TELEPHONE TYPE	QUANTITIES
Administrative Attendant Console	A/R
Multi-Line Digital Telephone	A/R
Single Line Wall Phones	A/R
Single Line Desk Phones	A/R

* A/R - Indicates as required by drawings.

B. Telephone Trunk Ports: Provide ports for the direct connection of 50 central office lines capable of operating with either loop start or ground start trunks for existing and future compatibility with utility services.

C. Digital Telephone Ports: Provide as required to support quantities indicated. Construct system with 20% spare capacity.

D. Single Line Telephone Ports: Provide as required to support quantities indicated. Construct system with 20% spare capacity.

MAIN DISTRIBUTION FRAME (MDF)

A. Provide special cabinet, floor to ceiling, with hinged doors for access to 66 type blocks. Back of cabinet shall have 5/8" plywood to mount 66 blocks. Size as required.

B. All wire from telephones shall be terminated on 110 type blocks in the MDF cabinet. All circuits in the CSE shall be brought out on 25 pair cables and terminated in the MDF cabinet on 66 type blocks. The 66 type blocks shall then be connected via jumper wires to the 110 type blocks. All circuits shall be identified by room and/or circuit number on the 110 block.

WALL PLATES AND JACKS

A. See Specification Section 260740.

1. SE-630-AD-6 6 Conductor, Wall Only
2. SE-630-ANS-6 6 Conductor, Desk Only

CABLING

A. Horizontal Telephone Cable:

1. See Specification Section 260740.

B. Back Bone Telephone Cable:

1. See Specification Section 260740.

POWER SUPPLY AND TRANSIENT/SURGE PROTECTION

A. AC Voltage Supply

1. Separately fused, 110 volt AC circuit fused with a circuit breaker of 20 amps.

2. Protect the AC supply with a Tripp Lite Model ISOBAR (IB) 2.0 AC outlet strip or equivalent.

B. Grounding: The cabinet housing the CSE and associated sound equipment shall be grounded to the building ground via a #6 AWG insulated copper wire.

C. Provide the following standby power equipment:

1. TrippLite Model (BX-750) or (BC-1200) battery backup system. Size as required for 60 minutes of operation.

2.4 INTERCOM/PUBLIC ADDRESS SYSTEM

A. Equipment Rack: Install all sound system components in an equipment rack. Simplex 5100-9810. Unit shall be 61” high with locking rear door. Provide blank panels as necessary to cover excess space. Install the equipment rack (s) on a roller truck with locking wheels to ease servicing and conservation of space.

B. Central Processor: Provide and install a CPU capable of supporting all speakers indicated on plans. System shall be capable of supporting up to 360 individual speaker zones. Simplex Model 5120 System.

C. AM/FM Tuner: Simplex 5100-9177 AM/FM Digital Tuner with Simplex 5100-9181 Roof Mounted Antenna Kit.

D. Compact Disc Player: Simplex 5120-9184 Compact Disc Player.

PERIPHERAL SYSTEM DEVICES

A. Backboards: Provide 4’x8’ plywood backboards for mounting of system cross connect field mount as shown on the plans. Provide modular termination backboards with 110 type terminal blocks as required to terminate all cables. Provide distribution and cross connect backboards equal to AT&T 110 Series for all cross connect wiring.

B. Intercom Speakers:

1. Ceiling Tile Installation (Round)
   a. Simplex 5120-9410 8" Speaker, 5 oz. Magnet
   b. Simplex 5120-9420 Round White Steel Baffle
   c. Simplex 5120-9491 Back Box w/ Tile Bridge

2. Wall Mount Installation (Square)
   a. Simplex 5120-9410 8" Speaker, 5 oz. Magnet
   b. Simplex 5120-9430 Square White Steel Baffle
   c. Simplex 5120-9492 Square Back Box

C. 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

D. 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.

E. Cabling:

1. Two-way intercom speakers: 2 conductor, 22 AWG, solid with shield, plenum.
2. Commons area speakers: 2 conductor, 18 AWG, stranded with shield, plenum.

F. 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
3	Classroom/Office Clocks
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 260771

SECTION 260772: CAFETORIUM SOUND REINFORCEMENT SYSTEM

PART 1 – GENERAL

1.1 SUMMARY

A. Scope: Extent of work is indicated on the drawings and by the requirements of this section. The Sound reinforcement system shall be capable of being operated in either of two modes as follows:

1. Unattended Mode

a. This mode shall be utilized for day-to-day operations. In the unattended mode, it will only be necessary for school personnel to power up the system, plug in a microphone and control volume. Two (2) microphone outlets, located stage right and stage left and clearly labeled for this mode, will be provided on the stage.

2. Production Mode

a. This mode shall be utilized for large productions. In the production mode, it will be necessary to utilize the mixing console.

1.2 QUALITY ASSURANCE

A. Codes and Standards: Provide products and materials conforming to the following:

1. Electronic Industries Association (EIA): Comply with the following EIA standards:

RS-160 Sound Systems
RS-299-A Loudspeakers, Dynamic Magnetic Structures and Impedance
RS-310-C Racks, Panels & Associated Equipment
SE-101-A Amplifiers for Sound Equipment
SE-103 Speakers for Sound Equipment

2. National Fire Protection Association (NFPA): Provide work complying with applicable requirements of NFPA 70 "National Electrical Code" including, but not limited to the following:

Article 250 Grounding
Article 300 Part A. Wiring Method
Article 310 Conductors for General Wiring
Article 725 Remote Control, Signaling Circuits
Article 800 Communication Systems

3. Comply with requirements of Underwriters Laboratories, Inc. (UL) 50. "Cabinets and Boxes."

B. Certification: Provide certificate of compliance with the referenced standards from the equipment manufacturer.

1.3 CONTRACTOR QUALIFICATIONS

A. The installation (electrical) contractor shall hire the services of a sound system contractor to supply the equipment, design, supervise and complete final checkout and certification procedures.

B. The sound system contractor shall be a factory authorized sales and service distributor of the specified equipment, and must provide with his submittals manufacturer documentation stating that they are in fact authorized distributors of the specified equipment.

C. Provide installation supervision by personnel, who are factory authorized service representatives of the specified equipment manufacturer and who currently provide maintenance service for equipment of the type specified.

PART 2 – GENERAL CONDITIONS

2.1 APPROVED EQUIPMENT

A. This specification is based upon equipment produced by various manufacturers. The authorized manufacturer's representative for all products is Simplex-Grinnell.

2.2 GENERAL

A. The intent of this specification is to provide a complete and satisfactory operating system for the pickup, amplification, distribution and reproduction of voice, symphonic, and other audio program material. All equipment and installation material required to fulfill the above shall be furnished whether or not specifically enumerated herein or on the drawings. All necessary hookup and installation shall be by a factory approved representative. The installation supervisor shall also instruct the personnel designated by the owner as to correct operation of the system. A minimum of 8 hours time for this training shall be included in the bid.

B. The contractor shall provide three complete sets of the following data, upon completion: installation wiring plans and diagrams, schematic drawings, complete instruction manuals, and service instructions.

C. The system shall be guaranteed for a period of one year from the date of acceptance or first beneficial use, whichever is first, against defective materials, design and installation. Any defects shall be repaired/replaced at no expense to the owner during normal business hours.

D. The work specified shall be performed by fully competent workmen, in a thorough manner. All materials furnished by the contractor shall be new, and all work shall be completed to the satisfaction of the Architect, Engineer and Owner.

E. At the time of submittal, the contractor shall submit a complete and accurate listing of all major items of equipment to be used in assembling the system, including all items of equipment listed under this specification, as well as contractor's block diagrams indicating the proposed interconnection of all equipment to be furnished. All modifications of standard equipment necessary to meet specifications shall be explained fully and must be accompanied by schematic diagrams.

F. All equipment, except portable equipment, shall be held firmly in place. This shall include loudspeakers, amplifiers, cables, etc. (The exception to this rigid-mounting clause is, of course, when it is required to use resilient shock mounting to de-couple the array from the structure it is being mounted to.) Fastenings and supports shall be adequate to support their loads with a safety factor of at least five (5). All switches, connectors, outlets, cables, etc., shall be clearly, logically and permanently marked during installation.

G. The contractor must take such precautions as are necessary to guard against electromagnetic and electrostatic hum, to supply adequate ventilation and to install the equipment so as to provide minimum safety to the person who operates it.

H. Care shall be exercised in wiring so as to avoid damage to the cables and to the equipment. All joints and connections shall be made with rosin-core solder or with mechanical connectors approved by the Engineer. All wiring shall be executed in strict adherence to standard broadcast practices.

I. The contractor shall submit to the engineer a "certificate of completion" to assure that the system has passed all the tests required in subsequent part of this specification and is in proper operating condition. Final tests shall be made in the presence of the engineer, who shall be notified of the test date a minimum of five (5) days prior to that date.

J. All wiring shall be type CMP, communications plenum cable, and install concealed in attic spaces and walls. Wiring shall be run in bridle rings spaced a maximum of 6 feet apart. Where wiring must be run down walls exposed, it shall be installed in EMT conduit for unfinished areas, and Wiremold raceway for finished areas.

PART 3 – EQUALIZATION

3.1 GENERAL REQUIREMENTS

A. Provide all required testing apparatus specified herein to complete successfully the equalization and tests. Provide factory trained personnel to perform the tests and adjust the equalizers required. The purpose of the equalization is to adjust the acoustic amplitude response of the sound system to a specified uniformity measured throughout the entire audience area. This adjustment is made to realize maximum acoustic gain and optimum tonal balance from the sound system throughout the audience area and stage monitored area.

3.2 INSTRUMENTATION

A. Prior to initial testing, the contractor must submit to the engineer a list of test equipment to be supplied by the contractor and the date calibrated. Provide the following minimal standard laboratory test equipment. Any substitutions or additions to the following list must be approved by the engineer.

1. An impedance bridge
2. Audio oscillator
3. Random-noise generator
4. Precision sound-level meter
5. 1/3-octave real-time audio frequency analyzer
6. Oscilloscope

Kits, home-built and other non-professional test equipment shall be unacceptable.

3.3 INSPECTION OF SOUND SYSTEM PRIOR TO EQUALIZATION

A. Prior to undertaking equalization of the sound system, perform the following inspections on the sound system, and submit to the engineer the written results of each inspection for inclusion in the permanent records of the sound system.

1. Measure and record the impedance of each loudspeaker line before connecting it to the output of its respective amplifier. The load impedance shall be equal to or greater than the rated impedance. Record the total impedance.

2. Measure and record the acoustic distribution of the loudspeaker in the sound system throughout the entire seating area. Record the location of all positions in the seating area where any 1/3-octave band, 350-5000 HZ, deviates more than +3dB from the desired house curve.

3. Measure and record with an oscilloscope, the output of each power amplifier. The input source to each amplifier being measured shall be a sinewy oscillator with less than 0.5% THE adjusted to 10dB less than full power output of the amplifier. Inspect the output sinewy appearing on the oscilloscope for complete freedom from hum and noise, parasitic oscillation and RH interference.

4. Adjust alignment delay for minimal comb filtering and lobing.

3.4 HOUSE-CURVE EQUALIZATION

A. Use pink noise as a source signal, and place a calibrated measuring microphone in the seating area at twice the critical distance (2Dc). (Critical distance is defined as that distance from the

sound source at which the direct sound from the source and the reverberation sound are in a ratio of one to one.) The acoustic amplitude response that appears on the screen of the real-time spectrum analyzer shall be recorded. Point-to-point measurement, averaging estimates and any other non-real-time dynamic measurements shall be unacceptable. After the unequalled acoustic amplitude response is recorded, the master equalizer set shall be used to bring the observed acoustic amplitude with +3dB uniformity and to conform to the predetermined high-frequency roll off dictated by the combination effect of humidity, air absorption, and the random incidence of the measuring microphone. The equalized house curve shall be recorded in graphic form and provided to owner.

3.5 DOCUMENTATION OF TESTS, MEASUREMENTS AND ADJUSTMENTS PERFORMED

A. The contractor shall provide the following documentation to owner:

1. List of personnel and certified test equipment used

2. Impedance of all loudspeakers

3. The variation of acoustic distribution throughout the seating area above and below a reference level at each 1/3-octave center frequency from 350-5000Hz.

4. The recorded inspection results observed for hum, noise, parasitic oscillation, and RH interference from the output of each power amplifier.

5. The equalized house curve made with the measuring microphone.

6. All filter settings.

PART 4 – EQUIPMENT

4.1 MIXING CONSOLE

A. The mixer shall have 12 input channels with internal power supply, with all connectors easily accessible.

B. The input channels shall have 3-pin XLR-type microphone inputs and ¼ inch balanced line inputs with a MIC/LINE switch to select the desired input. Each input channel shall have a gain control with a peak LED and a direct output and insert connector. The input channels shall have 3-band EQ with semi-parametric mids from 250 - 5 kHz with +/-15 dB of boost/cut. The input channels shall have 4 aux sends, 2-fixed pre-fader and 2-fixed post-fader. The input channels shall have 60-mm faders, mute and routing switches.

C. The mixer's output section shall have XLR- type 3-pin active balanced, low-impedance outputs for left, right, and mono and these outputs are controlled by 60-mm faders. There will be insert jacks on the master outputs. There shall be a headphone amplifier with level control and three-conductor ¼ inch phone jack mounted on the front panel. There shall be four master aux sends with level controls, after-fade listen and mute switches. There shall be two stereo aux returns with level and balance controls and routing switches. There shall be separate tape record output and playback controls with ¼ inch connectors.

D. The mixer shall have independent PC boards for each channel and use high-quality electrical components. There shall be an integral power supply with excellent current capacity and very low noise.

E. Dimensions shall be 4.29” H x 20.47” W x 20.03” D. Net weight shall be 26.45 lbs.

F. The mixing console (sound board) shall be manufactured by Electro-Voice, model M2/12.

4.2 MAIN SPEAKER SYSTEM

A. The loudspeaker shall be a multiple driver, full-range system with matched active equalization as follows:

1. The transducer complement shall consist of eight (8) full-range drivers of 11.4 cm diameter, mounted symmetrically in vertical pairs on a faceted, removable baffle assembly. Each driver shall have a rated impedance of 1£2 and shall be wired in series, resulting in a composite nominal impedance of 8 ohms.

2. The loudspeaker system sensitivity shall be 99dB-SPL in the 300Hz- 3kHz range and 92dB-SPL in the 50Hz- 16kHz range with both measurements referenced to a 1 Watt (2.83V) pink noise input at 1 meter. The nominal horizontal beam width shall be 120 degrees, and the nominal vertical beam width shall be 100 degrees. The power handling capacity of the loudspeaker shall be 240 Watts continuous pink noise, band limited from 50Hz to 16kHz.

3. The loudspeaker shall be provided with a ducted vent system, tuned at 55Hz. The input connectors of the 802 Series II loudspeaker shall consist of two (2) parallel-wired 1/4 inch (6.3 mm) phone jacks and two parallel-wired male XLR connectors.

4. The loudspeaker enclosure of the 802 Series II loudspeaker shall be composed of mica-reinforced polyethylene copolymer structural foam. Outer dimensions of the 802 Series II loudspeaker shall be 13" H x 20" W x 12" D, its weight shall be 31 lb.

5. The loudspeaker shall be the Bose 802 Series II loudspeaker system. For each speaker location, provide (2) speakers, one mounted on top of the other, stage left and stage right and also Gym side, Stage left and Stage right.

6. The loudspeaker system shall be supplied with a separate systems controller, to be connected before the inputs of the system power amplifiers. The fixed, 2-channel systems controller shall provide active electronic equalization and crossover functions. It shall include an operating mode switch, input sensitivity switch, low-frequency output level control, and mono sum switch.

7. The systems controller shall use screw-type terminal strips for balanced input and output wiring connections. Mount inside the auditorium sound system equipment rack.

8. The electronic controller shall be the Bose 802C Series II systems controller.

4.3 AMPLIFIERS

A. The power amplifiers shall be a dual-channel type capable of bridged mono operation. It shall deliver continuous power of 325 watts per side into 4 ohms or 200 watts per side into 8 ohms in a dual-channel mode, or 650 watts into 8 ohms in a bridged mono mode over the range of 20 to 20,000 Hz at no more than 1% distortion. The power amplifier shall be a Biamp Model CPA650, 650-Watt Power Amplifier.

B. Frequency response shall be 20 to 20,000 Hz (+0, -1 dB) with a noise level at least 98 dB below rated output. The unit shall be capable of balanced or unbalanced input operation without the need of additional components.

C. The amplifier shall provide passive cooling via extensive heat sink assemblies and shall not require fan cooling for normal operation. The amplifier shall be equipped with output short circuit and overload protection, along with automatic reset thermal protection.

D. Precision 31-position detented level controls shall be provided for each channel with the option for rear or front mounting without the need for additional hardware or circuitry. The controls shall be factory mounted on the rear panel. Each channel shall be provided with a peak level indicator on the front panel. Dual-channel or bridged mono operation shall be selected from a rear panel

mounted switch. A power on indicator shall be located on the front panel next to the power switch.

E. Balanced or unbalanced input connections shall be via a screw terminal strip. Output 5-way binding posts shall accept a variety of speaker connection methods. Speaker protection fuse holders shall be provided on the rear panel shall be factory equipped with fuses rated for 8-ohm operation. The fuses shall be easily exchanged with a readily available type to meet the speaker protection requirements of the application.

4.4 MAIN SIGNAL CHAIN

A. A signal chain consisting of, but not limited to the following, shall drive the main speakers:

(1) Biamp AutoOne automatic mixer (for unattended mode)
(1) Sabine FBX-1020 Plus Feedback Controller
(1) Biamp MEQ3011/3 Octave Equalizer
(1) Architectural Acoustics CEX 5 Processor
(1) Bose 802c Active Equalizers
(2) Biamp CPA650 Power Amplifiers

4.5 FOLDBACK SYSTEM

A. The foldback system shall be initially connected directly to the main signal chain. The signal shall be mixed through an aux send of the main console. Two female receptacles shall be provided in the floor boxes with the “wired” microphone jacks for the “on stage” monitor loudspeaker. The system shall be comprised of, but not limited to, the following equipment:

(1) Peavey Architectural Acoustics 115TF Speaker
(1) Biamp CPA650 Amplifier
(1) Sabine FBX-1020 Plus Feedback Controller
(1) Biamp MEQ3011/3 Octave Equalizer
(2) Monitor Speaker Jacks, to be incorporated in the same housing as the microphone jacks

4.6 WIRED MICROPHONES

A. The contractor shall provide the following equipment:

(1) Shure PG58 Vocal Microphone
(3) Soundolier S601-13C-PT wall mount microphone jack.

4.7 WIRELESS MICROPHONES

A. A Shure wireless microphone system shall be provided, configured as follows:

(4) ULXS24/58 Handheld Wireless Microphones with rack mount receivers
(1) UA845 Antenna/power distribution system (lot) ½ wave remote antennas and mounting hardware

4.8 PRODUCTION QUEING INTERCOM SYSTEM

A. A production intercom system shall be provided, consisting of the following components:

(1) Telex PS-1F Power Supply
(6) BP-1000 Beltpacks
(6) PH-1 Headsets
(6) ME-25 Cables
(6) WP-1 Wall Plates

4.9 MISCELLANEOUS EQUIPMENT

A. Provide the following miscellaneous equipment to form a complete and functional sound reinforcement system.

(2) Lew Electric Fittings Company floor boxes, model FFB-2-BE, each provided with one (1) microphone jack and one (1) 1/4" phono plug jack.
(2) Lowell L277-61 Floor Mounted Equipment Racks with casters.
Provide (3) 7" drawers for storage. Provide locking front and rear doors. Front door to be louvered type. Side panels to be louvered. Provide TP27-3 fan panel in top of each rack. Bolt racks together to form one unit.
(lot) Lowell RPC series power sequencers
(1) 25' Microphone cable

(As Required) Security Covers for all processing equipment
(As Required) Microphone and Monitor Speaker input/output XLR connector plates
(As Required) Equipment Rack Kits

PART 5 – WIRING

5.1 INSTALLER'S RESPONSIBILITIES

A. The installer shall coordinate the installation of the sound system equipment with the manufacturer's authorized representative.

B. All conductors and wiring shall be installed according to the manufacturer's recommendations.

C. It shall be the Installer's responsibility to coordinate with the supplier, regarding the correct wiring procedures before installing any conduits or conductors.

5.2 INSTALLATION OF SYSTEM COMPONENTS

A. System components shall be installed in accordance with the latest revisions of the appropriate NFPA pamphlets, the requirements contained herein, National Electrical Code, local and state regulations, and other applicable authorities having jurisdiction (AHJ).

B. All wiring shall be type CMP for plenum installations. All sound system cable shall be installed above the acoustic ceiling or contained in building walls. Where a device is mounted on a masonry wall, install conduit stub within wall from device backbox to top of wall. All wiring shall be concealed and all backboxes recessed, where possible. Where wiring cannot be concealed, install cables in EMT conduit. Where device backbox cannot be recessed in walls, provide the manufacturer's matching surface backbox.

C. Where wiring is run above acoustic ceiling or in attic space, install cables in bridle rings connected to building steel supports. Install bridle rings every 6 feet. Cables shall not be ty-rapped to any pipes.

D. Wire and cable shall be U.L. listed and be plenum rated, type CMP.

E. Raceway containing conductors identified as "Sound System" conductors shall not contain any other conductors and no AC current carrying conductors shall be allowed in the same raceway with the DC fire alarm detection and signaling conductors.

F. It shall be the responsibility of the contractor to coordinate the exact location of all installed equipment with all applicable trades.

G. Speaker circuit cables shall be run in separate bridle rings and conduit from microphone cables. Intercom wiring shall be run in its own dedicated bridle rings. These wiring runs shall be separated by at least 3 feet from each other.

PART 6 – GUARANTEE AND FINAL TEST

6.1 GENERAL

A. The contractor shall leave the sound 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 one (1) year (365 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.

6.2 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. 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 “Certificate of Installation" shall be completed and signed by the necessary personnel, stating that the system is installed in accordance with this specification.

6.3 AS BUILT DRAWINGS, TESTING AND MAINTENANCE INSTRUCTIONS

A. As Built Drawings

A complete set of reproducible "as-built" drawings showing installed wiring, specific interconnections between all equipment, and internal wiring of the equipment shall be delivered to the owner upon completion of system.

B. Operating and Instruction Manuals

Three (3) complete sets of operating and instruction manuals, each placed in a 3-ring binder, shall be delivered to the owner upon completion. Each manual shall contain a copy of the as-built sound system drawings. The instruction period for the owner or its representatives shall be 16 hours, performed during normal business hours.

END OF SECTION 260772

SECTION 260930: DIMMING CONTROLS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. The Electrical Contractors, as part of the work of this section, shall coordinate, receive, mount, connect, and place into operation all equipment. The electrical contractor shall furnish all conduit, wire, connectors, hardware, and other incidental items necessary for the complete and properly functioning lighting control and dimming system as described herein and shown on the plans.

B. This section includes the following:

1. General specification for a dimming and control system.
2. Specifications for four different control systems
3. specifications for three different dimmer systems
4. Installation and Checkout of equipment on job site.

1.3 MANUFACTURERS REQUIREMENTS

A. The equipment herein specified is manufactured by Leviton Lighting Controls Division, Tualatin Oregon (503)-404-5500 and shall serve to indicate the quality of equipment required. Base bid shall be for equipment by Leviton Lighting Controls Division. If alternate equipment is proposed, it shall be shown as an add or deduct from the base bid price and shall be subject to approval.

B. Other manufacturers who wish to bid must submit a complete bill of materials and company information listing qualifications and experience to the Architect ten days prior to bid date for permission to bid. All manufactures must comply with the specifications herein in every detail.

1.4 EQUIVALENT MANUFACTURERS

Strand
Lehigh
ETC

1.5 MANUFACTURERS SERVICES

A. Shop Drawings: Shop Drawings shall be submitted for approval within 30 days after receipt of contract. No fabrication of equipment is to proceed prior to approval of these drawings. Submittal package shall contain:

1. A complete bill of material
2. Sets of catalog cuts for standard equipment
3. Sets of shop drawings detailing all mechanical and electrical equipment including one line diagrams, wire counts, internal wiring, and physical dimensions of each item. Marked up catalog cuts are unacceptable.

B. Jobsite Checkout: Upon completion of all contractors wiring, and after all fixtures are installed and lamped, the contractor shall request the services of a factory representative to completely check out the system prior to energizing the system. At the time of checkout and testing, the owner's representative shall be thoroughly instructed in the proper operation of the system for a full day.

C. Documentation: Two complete sets of as built drawings shall ship with the equipment when it leaves the factory, along with operations and maintenance manuals for the dimmer system.

D. Ballasts: It shall be the responsibility of the installing contractor to insure that any fluorescent dimming ballasts supplied are compatible with the dimming equipment being furnished on this project.

E. Installation Instructions: Installing contractor shall follow manufacturer's installation instructions

F. Operation and Maintenance Instructions. Within two weeks after system turn-on is completed, the manufacturer shall provide three sets operations and maintenance manuals along with a copy of written warranty.

1.6 QUALITY INSURANCE

A. Source Limitations: Obtain dimming controls from a single source with total responsibility for compatibility of lighting control system components specified in this Section.

B. Performance Testing Requirements

1. All equipment shall be 100% tested as a complete system. Sample testing is not acceptable.

C. Code Requirements

1. All system components shall be UL listed and so labeled when delivered to job site.

2. Building Codes: All specified dimmers and scene controllers shall comply with the National Electrical Code. All units shall also comply with applicable, local building codes.

D. Installer Qualifications: Installer shall be one who is experienced in performing the work of this section, and who has specialized in installation of work similar to that required for this project.

E. Source Limitations: To assure compatibility, obtain dimming systems and controls from a single source with complete responsibility over all lighting systems and controls, including accessory products.

F. Manufacturer Requirements

1. Experience: The manufacturer will be one who has been continuously engaged in the manufacture of architectural lighting controls and dimmers for no less than ten years.

2. Testing: Manufacturer shall assemble all dimmers into dimmer cabinets and complete all internal wiring at the factory, prior to shipment. Testing shall be done as a complete, powered system: all dimmers shall be simultaneously connected to load banks, and all control stations shall be connected to the dimmer cabinet(s). Testing shall include exercising all functions such as take control, transferring, mastering, fading, or other special control provisions for each control and control station included in the system.

1.7 DELIVERY, STORAGE & HANDLING

A. General: Comply with Division 1 Product Requirements Sections.

B. Ordering: Comply with manufacturer's ordering instructions and lead-time requirements to avoid construction delays.

C. Delivery: Materials must be delivered, in a timely manner to other trades.

D. Storage and Protection: Store materials away from exposure to harmful weather conditions and at temperature and humidity conditions recommended by manufacturer.

1.8 WARRANTY

A. Manufacturer's Warranty: All equipment shall be warranted free of defects in materials and workmanship.

B. Warranty Period: 26 months from date of shipment or two years from date of turn-on, whichever occurs first.

C. Owner Rights: Manufacturer's warranty is in addition to, not a limitation of, other rights the Owner may have under contract documents.

PART 2 – PRODUCTS

2.1 DIMMING SYSTEM

A. General Description:

1. The dimmer rack shall contain 48 dimmer module slots for housing up to 96 dimmers.

2. The rack shall offer an option for a redundant control module that provides seamless backup in case of the main control module's failure or removal from the rack.

3. Each dimmer module shall monitor the temperature parameters for each dimmer.

B. Dimmer Rack Mechanical

1. The rack is built from extruded aluminum structural members with removable side panels of code gauge steel, measuring 86" high x 17" wide x 24" deep.

2. All exterior surfaces shall be finished in textured black powder coat finish.

3. Side, rear, top and bottom panels shall be easily removed without dismantling the rack.

4. Since the racks require no rear or side access, racks shall be able to be mounted back-to-back or side-to-side.

5. The front of the rack shall be completely open, allowing clear installer access to all line, load and control terminations.

6. Dedicated wire guides shall be mounted internally to aid in installation of load circuit wiring. Each load termination shall accept up to a #2 AWG wire.

7. The cooling fan and its control unit shall be mounted in removable modular housings for easy cleaning and maintenance.

8. Each dimmer shall receive fresh air through the door-mounted electrostatic filter.

9. Each rack shall have a locking door.

10. All dimmers shall be housed in removable modules made of die cast aluminum.

11. Each module shall contain one or two circuit breakers, a solid-state power switching device (SSR), a dimmer control PCB assembly, and two filter chokes.

12. All electrical contacts shall feature self-aligning floating connectors to insure precise alignment of all connections.

13. Modules shall be keyed so that a module of higher ampacity cannot be inserted into a slot that is wired for a lower ampacity dimmer.

14. All dimmer modules shall be inserted and removed without the use of any tools.

15. The rack shall be designed to operate on voltages ranging from 90-135VAC (120V nominal) at 50/60 Hz.

16. Rack shall be for use with four-wire three-phase or single-phase power. Simple rack-to-rack bussing eliminates the need to run separate line feeds to each rack.

17. The rack shall be UL listed and C-UL listed (for Canadian applications) with a short-circuit current rating of 100,000 RMS amps symmetrical providing listed dimmer modules are installed and the racks are not modified.

18. Optional current-limiting fault-current fuses (Amp-Traps) shall be available for other 100, 000 short-circuit current applications.

19. In systems that require a ground wire per load circuit, an optional ground bus shall be installed inside the rack.

20. All bussing, and all line and load terminal shall be copper.

C. Control Module

1. Each rack shall contain an electronic backplane with all control wiring connections on removable screw terminals for easy control wiring.

2. The backplane shall also retain all rack configurations, analog scenes, and backup scenes or looks in non-volatile memory, so that when any new control module is inserted, it automatically comes on-line, fully functional within ten seconds without requiring any programming by the user.

3. Each rack shall require a single control module that connects to the rack's electronic backplane.

4. Control modules shall be inserted and removed without the use of any tools.

5. Multiple control module outputs shall automatically pile-on to each other in a "highest takes precedence" fashion.

6. Each control module shall have three LED's to indicate the presence of voltage on each power phase.

7. The control module shall also contain LED's for overtemp, active control sources, panic and diagnostics.

8. The rack configuration and all backup scenes shall be able to be accessed through Hand-Held Terminal plugged into the front of the module, or remotely.

9. The 120V control module shall be UL Listed and C-UL Listed.

10. Each control module has an opto-isolated DMX512 input, a twelve-scene analog input and a 99-scene backup input. The module combines all inputs in a "highest takes precedence" manner. Analog scenes include snapshot capability.

11. Each dimmer shall be able to be programmed for the following operating parameters:

    a) Minimum and maximum level
    b) Non-dim operation
    c) Softpatch

12. Feedback information shall appear through the LED's of each dimmer module.

13. Feedback information to the control module for each dimmer shall include overtemp warning.

14. In addition to feedback from each dimmer, the rack shall monitor and provide feedback for the active voltage per phase.

15. Each rack comes with hardware-selectable Panic operation.

16. Terminals for dry contact closures shall be provided to initiate a Panic scene which shall drive all selected dimmers without affecting any other control setting.

D. Dimmer Module

1. The dimmer module shall be designed for superior reliability in the most demanding of operating conditions.

2. Each dimmer module shall monitors it's temperature and report this information to the control module.

3. Each dimmer module shall have a dedicated optically isolated control signal line from the control module.

4. The failure of one module shall not affect the operation of any other dimmer module.

5. Mechanical:

   a. All dimmers shall be housed in removable modules made of die-cast aluminum.

   b. Each module shall contain one or two circuit breakers, a solid-state power switching device (SSR), a dimmer control PCB assembly, and two filter chokes.

   c. The face of the module shall have a handle, the circuit breaker switches, air vents, and labeled LEDs for local feedback.

   d. The left side of the module shall have a wide section of spring steel to insure a proper fit for each module in the rack.

   e. All electrical contacts shall feature self-aligning floating connectors to insure precise alignment of all connections.

   f. Modules shall be keyed so that a module of higher ampacity cannot be inserted into a slot that is wired for a lower ampacity dimmer.

   g. All dimmer modules shall be inserted and removed without the use of any tools.

6. Electrical:

   a. The dimmer module shall designed to operate on voltages ranging from 90-135VAC (120V nominal) at 50/60 +/-1Hz.

   b. The load lugs in the rack shall be capable of accepting up to #2 AWG wire.

   c. The dimmer module electronics' firing signal shall be optically isolated to 4,000 Volts from the power semiconductors.

   d. The control signal from the control console shall be optically isolated from the control module electronics.

   e. The dimmer module shall be capable of withstanding the following adverse conditions without any interruption of operation:

      1) A complete dropout of line voltage for up to 10 milliseconds
      2) A line surge or sag of 25% of nominal operating voltage for at least 500 milliseconds
      3) Transient voltages up to 21/2 times the nominal line voltage

f. The module shall also maintain proper output voltage regulation with +/- 1 Volt for line voltage changes of up to 10% per second, and for line frequency changes of up to 1 Hertz per second.

g. Each dimmer shall be able to be programmed for the following operating parameters:

1) Soft patch
2) Minimum and maximum level
3) Non-dim operation

h. When a dimmer is set as a non-dim, it shall pass a full sine wave unregulated from the input voltage.

i. Each dimmer shall track overtemp and level conditions, and provides feedback to the LEDs on the face of the dimmer module.

j. Real-time feedback information to the control module for each dimmer shall include:

1) Over-temperature warning
2) Over-temperature shutdown.

k. Modules shall be available in standard (500microsecond) rise times. (350 microseconds for dual 5kW, 230V) measured from 10% to 90% at 90 degrees conduction angle under full load. Oscillographic evidence of rise time data shall be provided before approval of any alternated manufacturer is allowed.

l. Airflow modules shall be required in unused slots in order to maintain proper rack ventilation.

m. 120V units shall be UL listed and C-UL listed (for Canadian applications).

n.

Dimensions:	H	W	D
Dual & Single Modules	11/2” 3.8cm	121/2” 31.8cm	61/2” 16.5cm

o. i Series e Dimmer Modules Rise Time and Maximum Heat Loss Per Channel

Catalog#	Description (in Microseconds)	Rise Time	Current Rating Watts		Max Heat Loss Per Channel BTU/hr	Ton/AC
4-0011E	i500 1.8KW 120V Dual Dimmer Module	500	2 x 15A	70	239	.020
4-0012E	i500 2.4KW 120V Dual Dimmer Module	500	2 x 20A	93	317	.027
4-0014E	i500 6.0KW 120V Single Dimmer Module	500	50A	264	900	.076
4-0061E	i500 2.5KW 230V Dual Dimmer Module	500	2 x 15A	119	406	.034
4-0052E	i350 5.0KW 230V Dual Dimmer Module	350	2 x 25A	96	327	.028
4-0064E	i500 5.0KW 230V Single Dimmer Module	500	25A	224	764	.064
4-0031	i Series 15Amp 120V Constant Module		2 x 20A			

Provide the following:

Qty.	Catalog No.	Description
1	4-0112E	i96e Rack: 120V Standard Dual 1.8/2.4 kW
1	4-0112E	i96e Rack to contain 400A/3P enclosed circuit breaker/60A/2P furnished and installed by E.C.
1	4-0311E	Control Module 120V
48	4-0012E	i500e 2.4KW Dual Dimmer Module
23	4-0099	Filler Modules
1	40001-00	i96e Rack Ground Bus Kit

2.2 DIMMING SYSTEM OVERVIEW

A. The Dimension 8000 system shall be a lighting control system designed specifically for the control of architectural lighting. Large networks of wall stations can be assembled using Multiple Protocol Converters ("input/output nodes"), which are capable of utilizing several data transmission methods depending on the application. The network shall offer Lumanet III and Ethernet protocols as a minimum.

B. Multiple Protocol Converters ("input/output nodes) may be self-contained within the dimmer system or may be external devices that shall interface to the dimmer system though DMX-512. Multiple DMX I/O nodes may be provided for system redundancy where specified.

C. The system architecture shall be based on a peer-to-peer network, where the failure of any single component or node shall not cause loss of other system functions. Systems that require a central processor for system operation are not acceptable.

D. Systems shall be grouped in up to 128 station nodes to form a "subnetwork". Multiple Protocol Converters ("input/output nodes") can be used to join subnetworks together. Networks can contain both daisy chained and/or starred wiring configurations.

E. Each subnetwork shall use 2 or 3 pair RS-485 cable with maximum overall length of 5000 ft.

F. Each subnetwork shall use LUMANET III as the primary protocol.

G. Each node on a subnetwork shall have a unique logical identifier ("ID") numbered from 0 to 255.

E. Each subnetwork shall control a maximum of 2048 dimmer channels.

F. Wall stations may have up to 255 unique lighting control programs ("Personalities").

G. Station nodes may be linked to other station nodes on the same or different subnetwork. Linkages may be changed at any time by any other station or I/O node capable of transmitting the necessary LUMANET III commands.

H. Combine and Separate of adjoining rooms shall be accomplished by linking stations and/or through use of station personalities.

I. Ethernet protocol shall be ColorNet 2.0 (or later revision), TCP/IP based protocol. Protocol shall conform to and be fully compatible with all 10/100 BaseT TCP/IP routers and networks.

2.3 WALL STATIONS (Station Nodes)

A. Each Wall Station shall contain its own microprocessor, a LUMANET III connection, re-programmable flash memory for storage of operating program, and additional non-volatile memory for storage of lighting control programming data.

B. All station nodes shall be capable of having both the internal operating program updated and the lighting control program modified though the LUMANET network, utilizing an appropriate input/output node. Mechanical removal of the station from the installation location shall not be necessary. Systems that require removal of stations for updating the operating system or programming data are not acceptable.

C. All stations shall be capable of storing up to 255 unique sets of lighting control programming (Personalities).

D. Any station shall be capable of becoming a slave to any other identical station.

E. All buttons shall be captured mechanically to prevent inadvertent removal of button caps.

F. Presets may include any assigned dimmers even though those dimmers are assigned to other presets on the same or other Stations.

G. All stations shall have the ability to assign one of eight function security levels to any of the functions. The lowest security level shall be zero (any access). Seven shall be the highest security level. The station shall also have eight overall security modes. The function security level shall be required to be a lower number than the station security mode before the function can execute. A station security mode of eight will allow all function access. A station security mode of zero will not allow any function access. Station security mode may be set by keyswitch, remote device, or by local password (LCD station only). Systems that allow only one security level, or do not allow security levels for various functions within a station are not acceptable.

H. LCD Wall Station:

1. Station shall have a faceplate made of DuPont Corian™. A defined selection of standard colors is available. Additional DuPont Corian™ colors are available as custom.

2. Exposed station dimensions shall be 4-1/2”Hx8-7/16”Wx1/2”D. Station shall mount in standard 4-gang back box (min dimension 2-13/16”Hx8-1/8”Wx3”D).

3. Station shall contain a long life (50,000 hours min.) backlit LCD display. Electro Luminescent Displays are not acceptable. LCD shall be 20 characters by 4 lines. LCD shall display text as programmed. Text shall be unique to network selected station Personality (menu). LCD may also be used for local programming prompts.

4. The station shall contain 15 momentary push buttons. Buttons shall be selectively backlit by LED’s. Buttons shall operate in momentary or toggle modes. Pressing a button shall cause a pre-programmed lighting control command to be transmitted on the subnetwork.

5. Station shall allow local manual adjustment of assigned dimmer levels for each preset, utilizing the LCD display and pushbuttons. This feature shall be capable of being electronically locked out.

6. The Station shall allow the presets to optionally capture and store the current levels of assigned dimmers (SNAPSHOT), even though the dimmer levels originated from another station, control console, or other external source. Systems with LCD Stations that do not support snapshot function to its presets from multiple sources are not acceptable.

7. The LCD station shall be capable of storing up to 7 passwords. A station security mode from 1 to 7 shall be assigned to each password

8. The LCD station shall prompt for a password whenever a function is selected that has a security level that is higher or the same of the station security mode

9. The LCD Station shall have the option to automatically return to a preprogrammed personality (menu) and/or security mode in a preprogrammed time after station is idle

10. The LCD Station shall have selectable backlight level for active/idle conditions. The selections shall be: High/High, High/Low, and High/Off.

I. Pushbutton Wall Station:

1. Station shall have a faceplate made of DuPont Corian™. A defined selection of standard colors is available. Additional DuPont Corian™ colors are available as custom.

2. Exposed station dimensions shall be 4-1/2”Hx3”Wx1/2”D. Station shall mount in standard 1-gang back box (min dimension 2-3/4”Hx1-3/4”Wx2”D).

3. Station shall contain from 1 to 15 momentary push buttons. Buttons shall be selectively backlit by LED’s. Buttons shall operate in momentary or toggle modes. Pressing a button shall cause a pre-programmed lighting control command to be transmitted on the subnetwork.

J. Provide the Following:

Stage Manager Panel
Quantity 1 000-KLCDO-00B LCD Station
Panic Switch
Quantity 2 000-KB010-00W
Entry Stations (2-Button)
Quantity 2 000-KB022-00W

Manufacturer to Program Eight Preset Names on LCD Control

Preset 1	House
Preset 2	Hse/Stge
Preset 3	Assembly
Preset 4	Study
Preset 5	Band
Preset 6	Choir
Preset 7	A/V
Preset 8	Drama

K. Distribution Equipment

1. Pipe Battens

   a. All stage battens shall be 1-1/2” nominal diameter schedule 40 pipe with lengths as described above. All joints shall be sleeve spliced with 18” long sleeves with 9” extending into each pipe held by two (2) 3/8” hex bolts and lock nuts on each side of joint.

   b. All battens are to be hung level and plumb, and are to be supported by 3/8” all-thread and associated accessories, in conjunction with standard practices and manufacturer’s written instructions. This is to include any assemblies or additional supports as may be needed to provide adequate support.

   c. 1st and 2nd electrics shall be a double pipe batten with connector strip supports for the second pipe batten.

   d. Front of house shall be a single pipe batten with connector strip and terminal box mounted above. Electrical Contractor shall steel flex connect from terminal box to above ceiling junction box and transition to conduit to dimmer board. Electrical Contractor shall be responsible to paint all hardware and flex conduit black to match surrounding area.

2. Connector Strips

   a. Each section shall consist of a 4" x 4" (102mm x 102mm) 18 gauge steel wireway or extruded aluminum with removable cover sections for access, labeled with circuit numbers.

   b. Each strip shall have a terminal compartment which shall be factory installed on the right of left end as required and shall contain molded barrier type terminals for feed connection.

   c. The strip shall be provided with heavy steel mounting straps on approximately 5' (1.52m) centers, to grip up to 2" (51mm) pipe.

   d. Type S or SO, 18" (457mm) cable pigtails shall be secured by strain reliefs and shall be furnished with three pole grounded female receptacles. Flush receptacles are available in lieu of pigtails. Internal wiring shall be rated at 125 C.

   e. External finish shall be black powder coat epoxy. The entire unit shall be UL and CSA approved and labeled.

Provide the following:

Qty.	Catalog No.	Description

Connector Strip with locking Connectors
First, Second and Third Electrics

3	157-000	30' Long connector strip with (16) 20 AMP twist locking connectors mounted on 18" pigtails and wired on (17) circuits. Provided complete with terminal box, mounting straps, circuit labels and wire mesh.

Front of House:

1	157-000	25' long connector strip with nine (6) 20A twist lock connectors mounted on 18" pigtails and wired on nine (6) circuits. Provided complete with terminal box, mounting strips, circuit labels.

Connector Strip Accessories

Qty.	Catalog No.	Description
4	152-045	Wire mesh grip, large with loop 12/28 & 10/24 and larger cables

Note: #12 AWG and #10AWG multi-conductor cable drops to be specified per project requirements. Specify quantity, gauge, length of drops, and number of conductors required per drop. Include one ground conductor in each drop.

3. Gridiron Boxes

   a. Each unit shall be a surface mounted code gauge steel box located as shown on the drawings. The unit shall be provided with terminal strips for feed connections. Knockouts, cables clamps and "Kellums" cable grips shall be provided. Access shall be by means of a removable cover.

   b. Finish shall be black baked enamel and the entire unit shall be UL listed and CSA approved in Canada.

Provide the following:

Qty.	Catalog No.	Description
4	175-003	Gridiron Box, 14-21 circuits

K. Fixtures:

1. Border Lights: Electrical Contractor shall furnish and install border lights for 1st and 2nd electrics as indicated on plans and as mentioned above as part of base bid. Wiring to be installed and terminated at connector strip.

   a. Housing shall consist of die cast aluminum end plates, extruded aluminum rails secured to a code gauge steel housing with compartment dividers. All painted surfaces shall be baked high temperature black. Rated 600 volts, 660 watts continuous operation. Rated lamp seal temperatures shall not be exceeded.

   b. Unit shall be provided with leads at each end of the unit consisting of three(four) 3-wire, 600V, 200°C, UL listed conductors, 18" long in a silicone braided sleeve. Male and female connectors shall be provided as specified by catalog number

   c. For mounting, unit shall be provided with a heavy steel trunion securely fastened to each of the cast steel end plates and equipped with painted malleable iron C-clamps, adjustable for up to 2" ID pipe ("U" bolts not acceptable). Each unit shall be provided with

a tilt adjust knob. Optional castered carriage sets with trunions shall be provided for CVC lighting applications.

Provide the Following:

Qty.	Catalog No.	Description
10	216-046	6' Borderlight 4 circuits with Locking Connectors
20	138-059	Safety cables
144	230-010	Combination Color/Roundel Frames
	{238-021	Roundels-Red
36	{238-022	Roundels-Blue
	{238-023	Roundels-Green
	{238-024	Roundels-Amber
155		120 watt BR Lamp

2. Front of House Lights: Electrical Contractor shall furnish and install six (6) spot lights as indicated on plans and as mentioned below as part of base bid.

   a. Ellipsoidal Spotlights

      (1) Housing shall be constructed of die-cast and sheet aluminum, with a high temperature black finish.

      (2) Optical Train shall consist of a medium two-pin base socket accommodating 500, 750 or 1000 watt tungsten halogen lamp, a specular Alzak double-flatted reflector and plano-convex lens(es) of low expansion borosilicate glass, lens configuration A producing a field of B (See table below).

      (3) The gate assembly shall contain four adjustable nickel/chromium stainless steel framing shutters, each operating in its own independent plane through plus or minus 30o of rotation anywhere within the gate, with up to 120o total angular rotation between adjacent blades. These blades shall each be equipped with thermally-insulated handles with finger holes.

      (4) Each unit shall be provided with a pattern slot and an optional customer-installed iris assembly.

      (5) The socket assembly shall be designed for rapid filament alignment by use of a thermoplastic focus handle on the socket housing permitting precise peak/flat field control. The entire assembly shall be removable without tools for lamp replacement.

      Units which require tools for alignment or removal of lamp assembly are not equal and are not acceptable.

      (6) Socket shall be precision type TP-22, UL recognized, steatite insulated, of die cast aluminum construction, rated for 600 volts, 1000 watts, 250oC, continuous operation. The rated lamp seal temperatures shall not be exceeded.

      (7) Performance with a 1000 watt, 300 hour 3200oK lamp shall be C beam candlepower with a B field:

Unit Catalog No.	A Lens Configuration	B Field	C Beam Candlepower
650-01X	2-(4.5" x 6.5")	50o	68,500
650-02X	1-(4.5" x 9")1-(6" x 9")	40o	112,000
650-03X	1-(4.5" x 9")1-(6" x 9")	30o	154,000
650-04X	1-(6" x 9")	20o	224,000
650-05X	1-(6" x 12")	15o	308,000

650-07X	1-(8" x 14")	10o	563,000
650-08X	1-(10" x 23")	5o	939,000

(8) Unit shall be provided with a heavy steel yoke, a painted malleable iron C-clamp adjustable for up to 2" ID pipe with a tapped and threaded steel hanger pin, an insulated focusing handle on the rear, and a color frame holder. The unit shall rotate vertically through the yoke for ease of focusing.

(9) The unit shall be provided with 36" 3-wire VHT leads, with connector as specified by catalog number. The entire unit shall be UL listed.

Provide the Following:

Qty.	Catalog No.	Description
		Mount on front of house position pipe
4	650-0356	30o Ellipsoid with Locking Connector., C-Clamp, Safety Cable, and Color Frame
		Mount on Front of House
1	650-0456	20o Ellipsoid with Locking Connector, C-Clamp, Safety Cable, and Color Frame
1	650-0556	15o Ellipsoid with Locking Connector, C-Clamp, Safety Cable, and Color Frame
6	176-601	575Watt, 115V, 3050oK, 2000HR, HX-601

2.4 CONTROL CONSOLE (24/48)

A. General:

1. The control console shall be a microprocessor based lighting control system specifically designed and constructed for the control of theatrical and television dimming systems. The control console shall provide for the control of up to 1536 dimmers on a maximum of 384 control channels, a maximum 500 cues, and a maximum 512 automated device traits. Output shall be USITT standard (DMX-512), A super VGA color monitor with a minimum of 800 by 600 lines of resolution with a 0.28mm dot pitch shall be supplied as an option.

2. The operating program shall be stored in an internal non-volatile read-only memory. Off-line show data storage shall be accomplished with a high density 3 1/2" floppy disk drive. Operating program updates shall be available from the manufacturer's web site at no additional charge.

3. The console shall provide two modes of operation: two-scene preset operation and multiscene memory operation. In two-scene preset mode, the console shall provide two scenes of 24 control channels each. In multiscene memory mode, the console shall combine the two-scene channel fader controls into one scene of 512 control channels. Selection of the operating mode shall be accomplished in the Set Up display

B. Physical

1. The lighting control console shall be a freestanding table assembly with a separate video monitor. The console shall be no larger than 6" high x 15.5" deep x 46." long with a weight of 48 lbs.

2. The console shall be made of heavy-gauge sheet metal finished in a black with white and teal silkscreen graphics.

3. The console shall have a user-replaceable high voltage protection module that will protect the processor engine from any accidental high voltage entering via the control data line.

4. The video monitor shall be a high resolution super VGA monitor with a minimum of 600 by 800 lines of resolution and 0.28 mm dot pitch. The monitor shall be switchable to use either 90 to 132V AC or 180 to 264V AC.

5. The LCD display mounted on the surface of the console shall offer a minimum 256 x 64 pixels. The physical size of this display shall not be less than 1.2” high x 4.7” wide. Consoles not offering both video and LCD displays shall not be considered equal and thus shall not be acceptable.

6. The power supply shall be dual voltage, capable of 85V to 135V or 185 to 250V AC 50 - 60 Hz.

7. The console shall provide at least two (2) switched convenience outlets for providing power to the monitor and any peripheral devices.

C. Mechanical – The lighting control console shall provide, but not be limited to, he following features:

1. Grand Master to provide a master level for all operational functions.
2. A Black-out switch.
3. Airflow LED indicating a loss of proper airflow.
4. Two scenes of 24 channel potentiometers for two-scene preset operation.
5. 24 individually-programmed, fully overlapping pile-on submasters or effect masters with 8 pages for a total of 192 submasters.
6. 96 Bump buttons for momentary control of channels.
7. Two independent crossfaders to provide a split dipless fade between Scene A and Scene B, and Scene C and D.

The Memory section shall have the following controls:

1. A group of eight (8) keys for calling up various displays on the monitor. The displays shall allow level setting, previewing, and modification of show data.

2. Expanded numeric keypad used to enter information regarding cue levels, cue timing, cue attributes, groups, submasters, effects, profiles, patching, and set-up. Keys shall also be provided for recording cues, groups, intelligent devices, and submasters live from the stage display.

3. A cursor position keypad with directional arrow keys.

4. A set of 8 “soft” function keys for access of up to 8 different functions in each display or sub display. These keys may change function in each display to focus the operator’s attention on commands which are useful in that display and to reduce congestion of the control surface.

5. Eight (8) macro keys for operator access to up to 2000 operator-programmable macros.

6. A trackball for adjusting channel levels proportionally, video cursor movements, and edits.

7. Seven (7) wheels with integrated LCD for adjusting intelligent device traits.

8. Two Rate keys for assigning live rate control of a selected effect or cue fade to a wheel.

9. Two Load keys for loading cues to playback faders.

10. Two GO buttons for initiating fades between cues in the normal numerically sequential order. The GO button shall provide positive tactile feedback to the operator to confirm its operation.

11. Two HOLD keys for stopping currently running fades, and two BACK keys for initiating fades backwards through the normal cue sequence.

12. Four (4) 100mm Playback Faders grouped as two pairs for manual control of cue fades.

13. All channel faders submasters, and bump buttons operational in two-scene mode shall also be operational in multiscene mode.

D. Operational

1. Displays: The console shall provide the following displays that can be selected by the operator to appear on the monitor at any time:

   a. Stage shall allow viewing of live channel levels (that appear on the stage), whether they come from cue levels, submasters, effects, or manual control. All channel levels may be viewed simultaneously. Cue fader status, current stage cue and parameters and tracking mode also shall be indicated in the stage display.

   b. Preview shall allow blind viewing and editing of cues in memory. the operator shall be able to specify an exclusive list of channels to be shown in the display at any time. The current stage cue and parameters and tracking mode also shall be indicated.

   c. Cuesheet shall be a numerically sequential list of all cues and their timing parameters. The Cuesheet display also shall indicate effects, profiles, links, macros, follows, and cleanup status assigned to cues.

   d. Tracksheet shall be a spreadsheet matrix of cues and channel levels. Up to 32 cues or cue parts by 24 channels may be viewed at one time. The operator shall be able to specify an exclusive list of channels to be shown in the display at any time. The display shall automatically page, centering on the selected preview cue.

   e. Playback is a non-editable cue sheet display, also showing playback fader status and submaster levels. The submaster levels section may be compressed to show only which submasters are active, and thereby show more cue sheet information.

   f. Patch shall allow viewing and editing of dimmer-to-channel assignments, and proportional dimmer delimiting (patch at level). The Patch display shall also indicate dimmer profile assignments, virtual non-dim assignments, and parked dimmer status. Patch information shall be selectable in the following formats: by Channel, by Dimmer, Non-dim Dimmers, and Parked Dimmers.

   g. Device shall show the status of five (5) intelligent devices at a time.

   h. Setup allows configuration of the console and selection of peripheral operations. The Setup display shall indicate the following information

2. Each display shall have the following elements:

   a command line showing command strings prior to their entry.
   a command history showing the last command entered.
   a selection of up to eight soft key functions.

3. Channel levels shall be displayed in different colors to indicate their source of status. Different colors shall indicate levels from cues, submasters, or effects.

   To optimize the use of the display area two different modes of text display shall be available for the operator to choose from. 25 lines per screen or 50 lines per screen. Consoles which do not provide expanded display area shall provide a second CRT.

4. Two-Scene Preset Operation: Fading between scenes shall be accomplished with the split crossfaders. Each crossfader may be assigned a separate fade time of up to 999.9 seconds, or may be operated manually in real time.

5. Multiscene Operation: Channel levels for channels 1 to 96 may be affected at any time by either the individual channel faders or by the keypad. If a channel level has been set by the keyboard, manual control shall be regained by matching the current level with the channel/fader ("match & grab" operation). Channels 97-144 are addressable by the keypad.

E. Cues

1. Cues and cue parameters may be recorded in any order. Up to nine (9) cues may be inserted between numerically consecutive cues.

2. Each cue may have up to eight (8) separate parts.

3. A cue may be assigned split times for channel levels that increase and decrease.

4. Each cue or cue part may be assigned the following parameters (all times may be set in 0.1 second increments):

   fade and delay times.
   split fade and split delay times.
   manual fades.
   effects.
   Any effect assigned to a cue shall have its channel levels fade up (or down) in the cue fade time while the effect is running. Consoles which do not fade effects within cues are not considered equal and are not acceptable.
   links to cues out of sequence.
   link repetitions.
   When a link causes a loop, the number of repetitions of the loop may be specified.
   return to normal sequence.
   A return to the next cue in sequence may be specified after a linked execution of a cue out of numerical sequence.
   cue profiles.
   These shall be selectable from the list of sixteen (16) operator-defined profiles.
   macros.
   Any macro assigned to a cue shall execute when that cue is triggered.
   cleanup designation.
   A cue designated as a cleanup cue shall prevent any levels from tracking into subsequent cues.
   cue name.
   alphanumeric names may be assigned to cues.
   cue parameters (time, part, delay, profile, link, etc.) shall be accepted in any order when entered on the command line.
   groups.
   Any group may be assigned to a cue. When a group which is part of a cue is modified, the cue is likewise modified.

5. Cues may be recorded as tracking or not tracking, based on the tracking mode in effect at the time of recording. Three tracking modes shall be available: Tracking, Cue Only, and Cleanup. Cleanup mode shall prevent any kind of tracking whatsoever, and no zero levels shall be displayed while in Cleanup mode. Consoles which do not provide for user-defined cue recording modes are not considered equal and are not acceptable.

6. Cues, groups, and submasters may be recorded from any display, resulting in the recording of levels that are currently active on stage. Cues, groups, and effects may be created in the blind displays by selecting them by number within the preview display. Any editing done in the blind displays shall affect memory immediately without necessarily affecting stage levels (no use of the record keys is necessary). Consoles which require manual recording or recording in only limited displays are not equal and are not acceptable.

F. Groups: Any or all channels may be recorded at specific levels as a group. The console shall be able to record at least 500 different groups.

G. Submasters

1. Submasters shall operate in a Pile-on (highest level takes precedence), Inhibitive, or Effect mode. Visual indication of individual submaster modes shall be shown in the playback display.

a. Normal mode: channel levels under control of the submaster handle.

b. Inhibitive mode: Channels assigned to an inhibitive submaster shall have live stage levels output to dimmers only if the submaster is set above zero (the channel levels are proportionally “inhibited” by the current level setting of the submaster).

c. Effect mode: any effect shall be assignable to the selected submaster, operating proportionally at its current level setting.

2. Each submaster shall have a memory of its channel level assignments for the pile-on mode. When modes are changed, the submaster will retain the level settings for the pile-on/normal mode. Up to 8 pages of submaster memory shall be provided. Consoles which do not provide for individually programmable submasters, and do not offer 8 pages of submasters or at least 192 total submasters are not considered equal and are not acceptable.

3. Each bump button shall be able to be assigned independently to a combination of the following operating modes: momentery, solo, toggle or off. For convenience, the operator shall have the option of assigning the mode of all bump buttons in one command.

4. A fade up and fade down time shall be programmable to each submaster. When the bump button is pressed, the submaster or effect will fade up. It will then fade down when the button is released in the momentary mode, or when it is pressed a second time in the toggle mode. The default shall be a time of 0 for instantaneous bump button control.

H. Effects

1. 600 different special effects may be recorded; they shall consist of a series of steps which repeat, forward or reverse, in any combination of the following patterns (positive or negative): alternate, bounce, build, and random. Any of a pool of 1000 steps may be assigned to each effect. A step can be built using a cue, group sub, channel list or combination of any of the above. A different dwell time and active and inactive levels may be assigned to each step. The dwell time shall be able to be set in 0.1 second increments.

2. Effects shall be designated to operate, in cues or submasters, in pile-on and take-control with device traits. An effect may be assigned to fade up in a cue so that the effect shall continue to run through a series of cues. The effect shall continue unchanged until it is designated to fade down in a subsequent cue. While an effect assigned to a cue is running, additional effects may be faded up in subsequent cues to run simultaneously. All running effects may then be faded out individually or simultaneously. Consoles which require effects to be assigned to a separate fader or submaster or do not fade in and out as part of a cue are not considered equal and are not acceptable.

I. Tracksheet:

1. The Tracksheet display shall allow level setting and restoration or prevention of tracking to recorded cues. The display shall indicate to the operator which levels are tracking and which are not.

2. Any changes made to levels in the tracksheet shall affect tracking levels according to the currently selected tracking mode.

J. Patch

1. An electronic soft patch shall be provided for assigning control of the dimmers to specified channels.

2. It shall be possible to assign to each dimmer the following:
a proportional maximum output level when its patched control channel is at full.
a profile defining its output curve.
a status of "park" at a designated level.
a status of virtual non-dim. The trigger point shall be definable.

3. Channels may be assigned a device trait for controlling automated devices. This separates the channel from the main stage display.

4. It shall be possible to group like traits of automated devices into one control channel

K. Trackball Operation

1. Any channel list may be selected for control by the trackball. All channel levels under control of the trackball may be adjusted proportionally even after some have reached full or zero. Systems not offering trackball control shall not be considered equal and are not acceptable

L. Command Line Syntax

1. The operator shall be able to use any combination of the following items for constructing channel lists: channels, groups, submasters, effects, or cues. These lists may be created using the "and", "thru", and "minus" commands.

2. When recording cues, the cue parameters shall be accepted in any order on the command line. When editing cue parameters, it shall not be necessary to specify the currently selected (default) cue or cue part.

M. Miscellaneous Operation

1. Channel. levels shall operate on a “highest level takes precedence” or “last action takes precedence” basis whether the levels originate from channel faders, cues, submasters, or effects.

2. A "Release" command shall be provided to release captured channel levels to their settings prior to their capture.

3. A facility shall be provided for completing a "dimmer check".

   Naming: The following items can be assigned alpha-numeric names:

   show files
   cues
   groups
   subs
   effects
   devices
   profiles

   Each name can have up to 16 characters. Names can be used to recall items if desired. Naming shall be accomplished through keys that are integral to the standard console. In addition it shall be possible to enter names via PC compatible keyboard. Consoles that require separate keyboards are not equal and not acceptable.

N. Real Time Clock : It shall be possible to trigger up to 500 events using the built in real time clock. Systems not offering real time clock shall not be acceptable.

O. MIDI Interface: A system of MIDI Show Control Commands, general MIDI commands and MIDI Output commands shall be included. MIDI "in, out and through" receptacles shall be provided. Consoles that offer MIDI support software as an option shall include it to be considered equal.

P. Macros

1. For convenience, the operator shall have the option of recording of up to two thousand (2000) different macros.

2. It shall be possible to view all macros.

3. The macros shall be grouped into pages of eight (8) macros each, with the current page indicated in every display.

4. Up to 8 macros may be accessed remotely by contact closures.

Q. DMX Input

1. It shall be possible for the console to receive DMX signals. The console shall allow for two modes of use of the DMX input.

2. DMX signals may be merged.

3. A Nine (9) channel range may be used to select scenes and patterns

R. Setup

Setup shall provide as a minimum the following:

- Selectable dimmer protocols: Colortran digital signal (CMX) and the USITT standard (DMX-512), (AMX optional).
- A set of diagnostic programs to check the functioning of the internal electronics, the top panel controls, and the selected peripherals.
- Full printing functions which print current channel formats as specified by the operator.
- The ability to view and manage multiple show files on a single floppy disk.
- Commands to selectively retrieve specific show information from a floppy disk with the ability to renumber items and add them to the existing console memory. Consoles that will load only entire shows are not equal and not acceptable
- The ability to selectively clear cues, groups, effects, submasters, macros, patch, profiles, defaults, or the entire system from the console memory. Consoles that do not provide for selective clearing are not equal and not acceptable.
- An indication of the number of cues, groups, and effects that remain available in memory.

The ability to format 3½" High Density disks. Standard Pre-formatted (IBM PS/2 or compatible) disks may be used without console formatting. Consoles that require formatting of all disks or do not use a standard disk format are not acceptable. Setup shall provide a means for assigning devices and editing device definitions

S. Software Upgrades: Upgrades to the operating software of the console shall be able to be achieved by end user directly from a 3 1/2" floppy disk. Consoles that require the physical replacement of PROMS or other memory devices, or that require site visits by a technician or return of the console to the factory for program upgrading are not acceptable.

T. Options: The following items shall be available as options:

A second local monitor video card.
Gooseneck worklights. Up to (3) supported.
A Hand Held Remote with recording and playback capabilities.
A ink jet or laser jet printer.

High Resolution VGA remote video supplied through the ColorNet system.
Remote Macro switch interface.

U. Warranty

1. A complete two (2) year warranty covering all parts and labor shall be provided for the control console and its peripheral devices. All software updates to the console released during the warranty period of the console shall be available to the owner free of charge.

2. It shall be required of the owner that a warranty registration card be completed and sent to the manufacturer in order to validate the warranty.

Provide The Following:

Qty.	Catalog No.	Description
1	7-0096	Colortran Innovator 24/48 Control Console
1	31388-00	Second Video Card
2	7-5052	Console Worklight
2	7-2091	Video Monitor, Color
1	7-5062	Innovator 24/48 Dust Cover
2	7-5101	Monitor Dustcover
1	7-5067	Innovator 24/48 Touring Case
2	7-5091	Monitor Touring Case
2	7-3014	25' DMX Control Cable
4	7-4011	Flush Control In Connection Wall Plate (Furnish and installed as part of base bid)(single gang back box by others)

3. Refer to Floor Plans for additional control devices and fixtures.

PART 3 – EXECUTION

3.1 LOCATION

A. Site Verification: Verify that wiring conditions, which have been previously installed under other sections or at a previous time, are acceptable for product installation in accordance with manufacturer's instructions.

B. Field Measurements: The electrical contractor shall be responsible for field measurements and coordinating the physical size of all equipment with the architectural requirements of the spaces into which they are to be installed.

C. Inspection: Inspect all material included in this contract prior to installation. Manufacturer shall be notified of unacceptable material prior to installation.

3.2 INSTALLATION

A. The Electrical Contractor, as part of the work of this section, shall coordinate, receive, mount, connect, and place into operation all equipment. The Electrical Contractor shall furnish all conduit, wire, connectors, hardware, and other incidental items necessary for properly functioning lighting control and dimming as described herein and shown on the plans. The Electrical Contractor shall maintain performance criteria stated by manufacturer without defects, damage, or failure.

B. Compliance: Contractor shall comply with manufacturer's product data, including shop drawings, technical bulletins, product catalog installation instructions, and product carton instructions for installation.

C. Circuit Testing: The contractor shall test that all branch load circuits are operational before connecting loads to dimmer system load terminals, and then de-energize all circuits before installation.

D. Application of Power: Power shall not be applied to the dimming system during construction and prior to turn-on unless specifically authorized by written instructions from the manufacturer.

E. Electrical Contractor shall be responsible to fill out the panel schedules that are part of the shop drawings to which fixtures are on what dimmer. These schedules shall be typed and copied into each Owner's Manual and installed on back of door in each dimmer.

3.3 DEMONSTRATION

A. Lighting Control Systems: Upon completion of the work, the Stage Lighting Contractor shall submit three (3) copies of a detailed Operating and Maintenance Manual including as-built shop drawings, equipment descriptions and parts lists. The Stage Lighting Contractor shall go through the manual with Owner-designated personnel to demonstrate and explain the maintenance and operation of the systems.

B. Installing Contractor shall provide Owner with eight (8) hours of training on equipment. This contract shall include video taping of session and video tapes of instructions on the use of the equipment.

3.4 TESTING

A. Notification: Upon completion of the installation, the contractor shall notify the dimming system manufacturer that the system is available for formal checkout. Notification shall be given in writing a minimum of 18 days prior to the time factory-trained personnel are required on site. Manufacturer shall have the option to waive formal turn-on.

B. Turn-On: Upon completion of all line, load and interconnection wiring, and after all fixtures are installed and lamped, Manufacturer's Rep or, if waived, Contractor shall completely check the installation prior to energizing the system. Each installed dimmer system shall be tested for each level of brightness, proper ON/OFF operations, and proper LED illumination. Each installed control panel shall be tested with each scene: verifying that each dimmer-controlled fixture adjusts to the selected scene and that all scene-controller LED's illuminate properly. If hand-held remote control scene controller is specified and furnished, all operations shall be similarly tested.

C. At the time of checkout and testing, the owner's representative shall be thoroughly instructed in the proper operation of the system.

3.5 PROTECTION AND CLEANING

A. Protect all equipment after installation from damage during construction. If despite such protection, damage occurs, remove and replace damaged components or entire unit as required to restore units to their original, undamaged condition.

END OF SECTION 260930

SECTION 280721: FIRE ALARM AND DETECTION SYSTEMS

(Delete all reference to Electrical Contractor pulling/providing wiring. Wiring shall be by Simplex-Grinnell. Electrical Contractor owns all required boxes, conduit and pull strings to above accessible ceiling).

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK

A. It is the intent of these drawings, schedules and specifications to outline the scope of work required to furnish and install a complete and operating fire alarm and detection system for this project.

B. The following specifications and the associated drawings are for reference only and are to only indicate the intent for a required fire alarm system and the level of quality. These specifications and drawings shall not be used for the bases of providing a bid for the project. It will be the responsibility of the Contractor to obtain the services of a licensed fire alarm vendor in the State of Delaware to indicate the required items necessary for a complete and operational system as recognized by the NFPA, State Fire Marshal's Office and the ADA. This responsibility shall also include any coordination with fire protection interface, mechanical equipment shutdown, hood suppression interface, etc. During construction, the shop drawings shall be submitted and approved by the Authority Having Jurisdiction (AHJ). Any changes required by the AHJ during the shop drawing review or during the final walk-thru shall be the responsibility of this Contractor and shall not be passed on to the Owner, Architect or Engineer in the form of a change order.

C. Types of fire alarm and detection systems required in this section include the following:

Combination:	Manual and Automatic
Zoned:	Wing, Floor, Level, Area, Machine or Device
Non-Coded:	Continuous Signal

D. The system shall include all required hardware, raceways, interconnecting wiring and software to accomplish the intent of this specification and the contract drawings, weather or not specifically itemized herein.

E. All equipment furnished and installed shall be new and the latest state of the art products of a single manufacturer, engaged in the manufacturing and sale of the specified fire detection devices for over ten (10) years.

F. The system as specified shall be furnished, installed, tested and approved by the local Authority Having Jurisdiction, and shall be turned over to the owner in an operational condition. In the interest of job coordination and responsibility the installing contractor shall contract with a single supplier for fire alarm equipment, engineering, programming, inspection and tests, and shall be capable of providing a “UL Listing Certificate” for the complete system.

G. Coordinate with Mechanical Contractor to furnish operations for air handling unit shutdown.

1.2 QUALIFICATIONS OF INSTALLERS

A. Before commencing work, submit data showing that the manufacturer has successfully installed fire alarm systems of the size, scope, type and design in projects of this type.

B. The manufacturer’s vendor and his fire protection engineer shall have a minimum of five (5) years experience in, and be licensed and certified in, the design and installation of the selected fire alarm system being furnished for this project.

C. The installing contractor shall submit copies of all required Licenses and Bonds for his selected equipment vender, his fire protection engineer and his own as may be required by the City, County and State of Delaware.

D. The selected vendor shall be qualified by “UL” for certifying fire alarm systems. Upon completion of the installation the vendor shall certify the final system meets “UL” ongoing maintenance.

1.3 MANUFACTURER’S REPRESENTATIVE

A. This contractor shall furnish the services of a manufacturer factory trained and certified representative, experienced in the installation, operation, maintenance and service of the type of system being furnished. The representative shall be licensed in the State of Delaware. The representative shall supervise the installation, software documentation, adjustment, preliminary testing, final testing and certification of the system. The representative shall furnish the required instruction to the owner’s personnel in the system’s programming, operation and maintenance.

1.4 CODES, REGULATIONS AND STANDARDS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by basic designation only. The latest version of each listed publication shall be used as a guide unless the authority having jurisdiction has adopted an earlier version.

B. Factory Mutual (FM)

1. FM AG Approval Guide

C. National Fire Protection Association (NFPA)

1. NFPA 70 National Electrical Code (NEC)
2. NFPA 72 National Fire Alarm Code
3. NFPA 90A Standard for the Installation of Air Conditioning and Ventilating Systems
4. NFPA 101 Life Safety Code
5. NFPA 170 Standard Fire Safety and Hazmat Symbols

D. Underwriters’ Laboratories, Inc. (UL) Appropriate “UL” equipment standards

1. “UL” 864 Control Panels
2. “UL” 268 Smoke Detectors
3. “UL” 268A Smoke Detectors (HVAC)
4. “UL” 1076 Security
5. “UL” 1971 Standard for Visual Signaling Appliances

E. Building Codes

1. BOCA National Building Code and the BOCA Fire Code
2. Standard Building Code and the Standard Fire Code
3. Uniform Building Code and the Uniform Fire Code
4. International Building Code and the International Fire Code

F. State Codes and Regulations

1. Delaware State Fire Prevention Commission
2. State of Delaware
3. State Fire Prevention Regulations as amended through January 2017
4. Americans with Disabilities Act of 1990 and/or State and Local equivalency standards adopted by The Authority Having Jurisdiction.

1.5 COORDINATION

A. As a requirement of this project, this Contractor and/or his subcontractor or vendor shall furnish coordination for his equipment and layouts with other subcontractors or vendors furnishing equipment and services for 1 thru Division 23. Any and all contractors who install their equipment

or furnish services prior to coordination, or 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.

B. The Mechanical, Plumbing, Fire Protection and this Contractors are responsible to coordinate all manufacturer's recommended sizes for all circuit breakers, starters, disconnects, fuses, wire and conduit 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 different 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.

1.6 SUBMITTALS

A. The installing contractor shall include the following information in his shop drawing equipment submittal:

1. Submit manufacturer's data on fire alarm and detection systems including, but not limited to, roughing-in diagrams and instructions for installation, operation and maintenance, suitable for inclusion in maintenance manuals. Also include a standard of a typical riser diagram and wiring diagram for equipment to be furnished and installed under this contract.

2. The fire alarm devices and equipment shown on the floor plans is indicated strictly to show intent and coordination with other trades, and shall not be taken to indicate a complete fire alarm and detection layout; meeting all NFPA, State and local codes for this project. It shall be the responsibility of the Contractor's sub-contractor/vendor and his fire protection engineer to produce a complete set of drawings indicating all required equipment, devices, wiring diagrams and components needed to meet and fulfill the requirements of the NFPA, State of Delaware's Office of the Fire Marshal and the Authority Having Jurisdiction.

3. One (1) complete set of the entire submittal shall be forwarded to the local Fire Marshal's Office for approval. The submission shall also include the following:

   a. Power calculations. Battery capacity calculations. Battery size shall be a minimum of 125 % of the calculated requirement.
   b. Supervisory power requirements for all equipment.
   c. Alarm power requirements for all equipment.
   d. Power supply justification showing power requirements for each of the system power supplies. Power supplies shall be sized to furnish the total connected load in a worst-case condition plus 25 % spare capacity.
   e. Voltage drop calculations for wiring runs demonstrating worst-case condition.
   f. NAC circuit design shall incorporate a 15% spare capacity for future expansion.

   The plan review by the Fire Marshal's Office shall be forwarded to the Project's Engineer, signed or under cover sheet, of approval from the Fire Marshal, as a shop drawing, once received in triplicate.

4. Complete manufacturer's catalog data including supervisory power usage, alarm power usage, physical dimensions, finish and mounting requirements.

5. Complete drawings covering the following shall be submitted by this Contractor for the proposed system:

   a. Floor plans in a CAD compatible format showing all equipment and raceways, marked for size, conductor count with type and size, showing the percentage of allowable National Electrical Code fill used.

b. Furnish a fire alarm system matrix as referenced by NFPA 72 figure A-7.5.2.2 (1999). Matrix shall illustrate alarm input/output events in association with initiation devices. Matrix summary shall include system supervisory and trouble output functions.

c. Include any and all departures, exceptions, variances or substitutions from these specifications and/or drawings at the time of bid.

6. Should the above-mentioned information not be included in the shop drawing submission, the submission shall be rejected without processing and returned to the contractor.

PART2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

1) Simplex.
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A. These specifications are designed and written in such a manner as to represent the minimum Fire Alarm and Detection System requirements. Any other components not indicated in these specifications, but deemed necessary by the selected manufacturer, for a complete and operational system, shall be included at no additional cost to the Owner.

B. Once the vendor's design has been through the Fire Marshal's Office, and received his approval and been submitted as shop drawings any additional devices required by the Fire Marshal shall be taken from the spare equipment list. Refer to Paragraph 5.3 SPARE EQUIPMENT herein.

2.2 GENERAL SYSTEM OPERATION

A. When an alarm occurs on an initiating device, the control panel indicates the alarm condition until manually reset.

B. An alarm may be acknowledged by actuating the "ACKNOWLEDGE" switch. This shall silence the panel buzzer, and change the "SYSTEM ALARM" LED from flashing to steadily lit.

C. This project shall be provided with synchronized audible and visual signaling devices. Activation of the signal silence switch at the fire alarm panel shall cause the audible signal to stop. The visual signal shall continue. If a subsequent initiating device causes an alarm, the audible signal shall resound. The visual signals shall continue until the system is reset. Synchronization shall be provided so that horns and strobes on different circuits will operate in unison.

D. If the microprocessor fails, the system shall execute a default signaling program. This program will enable the panel to sound the audible signals and summon the Fire Department. Inability of the system to sound signals or summon the fire department during microprocessor failure shall not be acceptable.

E. A single ground or open on the system signaling line circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm from all initiating devices. A wire to wire short on the signaling line circuit shall cause fault isolation modules on either side to open allowing operation of all analog/addressable devices not located between the activated fault isolation modules.

2.3 SPECIFIC OPERATIONS

A. Operation of a manual station or automatic activation of any smoke detector, heat detector, or kitchen hood suppression system, shall cause the following:

1. Indicate on the Fire Alarm Control Panel and Annunciator Panels the specific device in alarm via the English-language alphanumeric display. The "ALARM" LED shall also flash and the local audible device shall pulse.

2. All strobes to flash in unison. All speakers throughout entire building to broadcast a “Code 3” pre-alert tone followed by a prerecorded voice message of the owner’s choice.

3. Shutdown all air handling units in the vicinity of the alarm. Provide an addressable relay module at each air handling unit for connection to the low voltage shutdown control circuit. If a 120VAC control circuit is to be interrupted by the fire alarm system, provide an addressable control relay and isolation relay rated for the control circuit load.

4. Printing and history storage equipment shall log the information associated with each alarm condition, along with the time and date of each occurrence.

5. Release all electrically locked or held-open doors.

6. Transmit the fire alarm condition to a U.L. listed central monitoring station, to dispatch the local Fire Department.

B. Supervisory/Trouble Operations

1. Alarm activation of a duct mounted smoke detector or sprinkler valve tamper switch, shall cause the exact device in alarm to be displayed on the fire alarm panel and remote annunciator alphanumeric display, and initiate a supervisory condition within the fire alarm panel.

2. Transmit a supervisory condition to the central monitoring facility.

3. Duct mounted smoke detectors, when in alarm, shall cause their associated air handling unit to shut down.

4. Activation of any trouble condition within the fire alarm system shall cause the trouble visual and audible indicators to operate within the fire alarm panel, the reason for the trouble condition to be shown in plain English on the alphanumeric display, and a trouble condition to be transmitted to the central monitoring facility.

C. The fire alarm system is to be connected to a U.L. listed central monitoring station, with the following requirements:

1. The entire installation shall comply with the requirements of NFPA 72, 2002 Edition (Remote Station Protective Signaling System) utilizing a Digital Alarm Communicator Transmitter (DACT) and a Digital Alarm Communicator Receiver (DACR).

2. The fire alarm system shall transmit alarm, trouble, and supervisory conditions, a daily test signal and the other signals required by NFPA 72.

3. The contractor shall be responsible for the entire installation (wiring, mounting of system components, connections at panel and the Digital Alarm Communicator Transmitter, programming, and functional testing).

4. The contractor shall coordinate with the owner to provide off-site monitoring of the fire alarm system. Off-site monitoring shall be provided by the owner’s U.L. listed central station facility, and paid for by the Owner.

5. The owner shall be responsible for providing two (2) standard telephone lines at the rate demarcation point for connection to the fire alarm system dialer, and pay for all charges from the telephone company.

6. Digital alarm communicator transmitter shall be an integral component of the fire alarm control panel, and not a separate unit.

D. The fire alarm control panel shall be provided with a firefighter's one-way voice paging system.

1. The one-way voice paging system shall consist of a voice command center audio message generator with microphone and all-call pushbutton, pre-recorded voice message chip, speaker circuits with selector switches/status indicators, and audio amplifiers.

   Provide a minimum of (1) speaker circuit per area required to have voice evacuation signaling. Speaker circuits to be wired using a Style Y (Class B) circuit. Speaker circuits shall be provided with a maximum usage of 80% of it's rated maximum output, to allow for future additions. Provide calculations and supporting data in submittal booklet, for verification by review authorities. 25 watt audio amplifiers shall be provided so that no amplifier will exceed 80% of it's maximum capacity, to allow for future additions. Provide calculations and supporting data in submittal booklet, for verification by review authorities.

E. The fire alarm control panel shall be provided with strobe indicating circuits. Strobe circuits to be wired using a Style Y (Class B) circuit. Auxiliary power supplies and circuits shall be provided so that neither power supply or circuit will exceed 80% of it's rated output, based on the strobe light intensities required by NFPA 72. Provide calculations and supporting data in submittal booklet, for verification by review authorities.

F. The fire alarm control panel shall be provided with a minimum of two (2) signaling line circuits, so that no one circuit exceeds 80% of it's rated maximum. Provide calculations and supporting data in submittal booklet, for verification by review authorities.

   Signaling line circuits shall be wired using a Style 7 (Class A) circuit, incorporating fault isolation modules. Provide the required quantity of fault isolation modules so that no more than 20 analog/addressable devices are located between modules.

G. The fire alarm control panel components shall be housed in multiple cabinets of the same dimensions. All components shall be integrally compatible with the main central processor, to provide a neat, and professional appearance. The use of separate central processors, strobe power supplies, or audio evacuation panels at the main fire alarm control panel location is forbidden. Remote audio/visual power supplies, as shown on the drawings, is acceptable. Care shall be taken during the system design phase so that both audible and visual signals located in the same viewing area will be synchronized.

PART 3 – SYSTEM COMPONENTS

A. The fire alarm control panel shall contain a microprocessor based Central Processing Unit (CPU). The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent detectors, addressable modules, printer, annunciators, and other system controlled devices.

1. The control panel shall provide for the connection of 250 intelligent/addressable devices, without adding any additional components. If more than 250 device count is required, provide additional central processor units as necessary to meet job requirements and spare capacities.

2. The central processor unit shall provide the following features:

   a. Individual microprocessor design with degrade mode operations
   b. Cooperating multi-detector sensing algorithms that allow the fire alarm panel to interpret signals from adjacent detectors to make an alarm decision.
   c. Fully field programmable
   d. RS-232 output, standard
   e. Alarm verification – provide 30 second verification of alarm condition for all analog sensors

f. Drift compensation
g. Dirty detector and excessively dirty detector indications
h. Analog sensor sensitivity testing from the fire alarm panel, meeting requirements of NFPA72
i. Dual walk test modes
j. Individual point or zone read, and point or zone enable/disable
k. Nine(9)sensitivity settings for analog smoke detectors

3. Provide integral audio message generator with microphone and all-call button, pre-recorded voice message chip, speaker circuits with selector switches/status indicators, and audio amplifiers.

4. Provide integral strobe circuits with selector switches/status indicators, auxiliary 24VDC power supplies, and signal synchronization modules.

5. Provide integral digital alarm communicator transmitter.

6. Provide battery backup.

B. Display Interface Assembly

1. The display interface assembly shall provide all the controls and indicators used by the system operator and may also be used to program all system operational parameters.

2. The display interface assembly shall include status information and custom alphanumeric labels for all intelligent detectors, addressable modules and software zones.

3. The display shall provide a 640 character back-lit alphanumeric liquid crystal display (LCD). It shall also provide 10 light emitting diodes (LEDs), that will indicate the status of the following system parameters: AC POWER, FIRE ALARM, PRE-ALARM, SYSTEM TROUBLE, SUPERVISORY, SIGNAL SILENCED, CPU FAILURE, POINT DISABLED, SECURITY ALERT, AND OTHER EVENT.

4. The display shall provide a QWERTY keyboard with control capability to command all system functions, entry of any alphabetic or numeric information, and field programming. Ten different password levels shall be available to allow customized levels of operator access to programming, point status and alter status menus. This shall be used by the owner to assign different levels of control and bypass capabilities to different employees based on their individual level of experience.

5. An intuitive user guidance program shall be standard, allowing personnel without any prior experience the ability to follow easy step-by-step instructions to access all information related to an alarm, supervisory, or trouble condition.

6. Five (5) dedicated pushbuttons shall be provided allowing simple “scroll by event” operations for particular active conditions in the system. One (1) button shall be provided to scroll only “Fire Alarm” conditions, one for “Security Alarms”, one for “Supervisory Alarms”, one for “Trouble Conditions”, and one for “Other Events”.

7. An interactive summary event counter shall be provided on the alphanumeric display to show the number of alarms, troubles, or supervisory conditions in the system.

8. The display shall include the following operator functions: SIGNAL SILENCE, RESET, DRILL AND ACKNOWLEDGE. In a network system, these commands shall be completed for the entire network.

9. Fire alarm systems that cannot provide the high level of display and control functions, as outlined, are not acceptable.

C. Secondary Power Source

A secondary power source consisting of lead acid batteries shall be provided. Batteries shall be of sufficient capacity to provide power for the entire system upon loss of normal 120VAC power for a period of twenty-four (24) hours, with five (5) minutes of alarm signaling at the end of this twenty-four (24) hour period. However, the batteries provided shall be able to meet the high alarm current required. Remote audio/visual power supplies shall be provided with (24) hours of supervisory operation and (5) minutes of alarm operation.

PART 4 – PERIPHERAL DEVICES

4.1 REMOTE ALPHANUMERIC ANNUNCIATOR

A. The remote alphanumeric annunciator shall provide an 80-character alphanumeric display, along with system control buttons. Unit shall be mounted in a recessed backbox with smoked lexan window and key lock.

B. Provide a color, CAD-generated map of the building plan with suitable frame at the fire alarm control panel and remote annunciator panel(s) locations.

4.2 ADDRESSABLE MONITOR MODULE - STYLE B

A. The addressable monitor module shall be a normally open (N.O.) contact type detection device which communicates with the system through the signaling line circuit. The module shall contain a sub-loop that is wired Style B (Class B) and supplies an address for UL listed normally open contact devices on the sub-loop that close on alarm. When any open contact closes, the module address is transmitted to the fire alarm control panel system and indicates on the 80 character alphanumeric display.

B. The module shall be mounted in the same enclosure as any normally open device that it monitors - if space permits - or it can be mounted in a standard 4-inch square or octagonal electrical box.

C. Use for connection to manual pull stations, remote power supplies, etc.

4.3 ADDRESSABLE MONITOR MODULE - STYLE B/D

A. The addressable monitor module shall be a normally open (N.O.) contact type detection device which communicates with the fire alarm control panel through the Addressable Monitor Module FMM-1. The module shall contain a sub-loop that is wired either Style B (Class B) or Style D (Class A) and supplies an address for UL listed normally open devices on the sub-loop that close on alarm. When any open contact closes, the module address is transmitted to the fire alarm control panel and indicates on the 80 character alphanumeric display.

B. The module shall be mounted in a standard 4-inch square X 2 1/8 inch deep square electrical box.

C. Use for connection to sprinkler waterflow/valve tamper switches, kitchen hood suppression panels, fire pumps, emergency generators, etc.

4.4 ADDRESSABLE OUTPUT MODULE

A. The Addressable Control Module shall energize upon alarm from any analog detector or monitor module or any combination of detectors and modules communicating with the fire alarm control panel, or upon trouble from any analog detector or monitor module or any combination of detectors and modules communicating with the fire alarm control panel. A break in the wiring or removal of the module results in a fault message displaying on the panel, and the occurrence of a System Trouble. The module provides (2) sets of dry, form "C" relay contacts rated 2.0 Amp @ 30VDC (resistive). The module is used to supervise and control a Style Z or Style Y indicating appliance circuit when 24VDC is supplied to it from the Power Supply or Auxiliary Power Supply in the fire alarm control panel.

B. The modules shall be mounted in a standard 4-inch square X 2 1/8 inch deep electrical box, with a 1 1/2 inch extension ring.

4.5 FAULT ISOLATOR MODULE

A. The module shall enable part of the signaling line circuit to continue operating when a short circuit occurs on it. A LED indicator shall blink in the normal condition and light during a short circuit condition. The module shall automatically restore the entire communications loop to the normal condition when the short circuit is removed.

4.6 MANUAL STATIONS

A. Manual stations shall be made of red phenolic resin plastic with "Fire" lettering, for semi-flush or surface mounting, and shall be of the double action design.

B. The station shall require two (2) distinct operations to actuate.

C. Once activated, stations shall not be resettable without the use of a key and physically opening the station to reset.

D. The key shall be the same as that used to open the control panel.

E. Provide monitor module for connection to the fire alarm system signaling line circuit.

G. Provide protective guard with 9VDC integral sounder, Safety Technology International model STI 1100 (flush) or STI 1200 (surface), for each manual pull station.

4.7 AUTOMATIC INITIATING DEVICES

A. Analog Photoelectric Sensor

1. These detectors shall be of the photoelectric type, using a light scattering diode and photo sensor, and of the low-profile design. Maximum height of detector shall be 2 inches.

2. Detectors shall be designed for two-wire non-polarized installation and multiple listed with control units having specific voltage current characteristics which are compatible with the detector circuitry.

3. The detector shall have 360° angle orientation (circumference) smoke entry characteristics, permitting maximum response to both visible and invisible products of combustion from any direction. The detector shall be capable of operation at altitudes up to 7,500 feet without adjustments.

4. The sensors shall continually monitor to measure any change in their sensitivity due to the environment (dirt, smoke, temperature, humidity, etc.). They shall give an advance indication to the fire alarm control panel of the need for maintenance and can be specific as to where the maintenance is needed. If local regulations permit, then selected maintenance may be performed as opposed to having to check the sensitivity of all sensors to assure overall performance when only a few may be dirty.

5. The sensor shall be of plug-in construction and is directly interchangeable in the same base with the analog heat sensor. A wide variety of bases, with built-in horn, etc. are available.

6. Remote LED annunciator capability shall be available as an optional accessory.

7. The sensor shall feature fully coated circuit boards, special insect and dirt protection and superior RF/transient protection.

8. The unit may be tested from the control panel or functional testing can be performed by applying a test magnet according to the test procedures.

9. The Analog Photoelectric Sensor shall be mounted to a standard 4-inch octagonal electrical box.

B. Duct-Mounted Smoke Detector

1. The contractor shall furnish and install where shown on plans.

2. The duct housing contains an integral analog photoelectric type smoke detector. The exhaust sampling tube shall be molded into the base of the duct housing.

3. The detector shall be listed by Underwriters Laboratories, Inc. and approved by Factory Mutual under the current standards for photoelectric type duct smoke detectors - to allow remote functional testing without generating smoke.

4. Provide a remote test station for all duct mounted smoke detectors. Locate directly below unit in the suspended acoustic ceiling, or on wall at accessible location.

C. Analog Thermal Sensor

1. The analog thermal sensors shall contain a state of the art electronic dual thermistor sensing circuit for fast response. These sensors provide open area protection with 50 foot spacing capability for rate of rise type and 25 feet spacing for fixed temperature type.

2. Two (2) LED's on each sensor light upon alarm and provide a local 360° visibility of alarm indication. The LEDS flash each time the unit is interrogated.

3. The sensor shall be of plug-in construction and is directly interchangeable in the same base with the intelligent photoelectric smoke sensor. The bases shall include a tamper-proof feature which, when activated, prevents removal of the sensor without the use of a tool.

4. The Analog Thermal Sensor shall be mounted to a standard 4-inch octagonal electrical box.

4.8 FIRE ALARM SIGNALING APPLIANCES

A. Audio Signaling Appliance (Speaker-2 watt maximum)

1. Speaker shall be comprised of a 4” voice cone with magnet, 25 watt audio transformer with ¼ / ½ / 1 / 2 watt taps, and a flush mount grille. Provide U.L. listed backbox skirt for a finished and professional appearance, where surface mounted. Provide 4” speaker support bracket for drop ceiling installations.

2. Unit to be white in color.

B. High Output Audio Signaling Appliance (Speaker - 15 watt maximum)

1. Speaker shall be of the re-entrant compression driver type, 4” square voice cone with magnet, 25 watt audio transformer with multi-tap configuration up to 15 watts, and a semi-flush housing. Provide U.L. listed backbox skirt for a finished and professional appearance, where surface mounted.

2. Unit to be red in color.

C. Audio Signaling Appliance (Trumpet Speaker)

1. Speaker shall consist of a high compression driver mounted to a cone shaped projector. Unit provided with an integral 25 watt audio transformer with multi-tap configuration up to 15 watts. Provided with an adjustable mounting base for exact directional positioning.

2. Unit to be red in color.

D. Visual Signaling Appliance

1. Device color shall be red for wall mounted applications, and white for ceiling-mounted applications.

2. Unit shall produce a 15, 30, 75, 95, or 110 candela light output according to the UL1971 Polar Light Distribution measurement. It shall also produce the same light output near center axis. Strobe intensity to be provided as required by NFPA 72. Light intensities shown on drawings shall be used only as a basis for design. Field survey and adjust, if necessary, at no additional costs.

3. The unit shall be semi-flush mounted, if possible.

4. If the unit is to be surface mounted, install the matching backbox provided by the equipment manufacturer. The surface backbox shall be a finished product. Painted 4" square electrical boxes shall not be permitted.

5. The strobe shall provide synchronized operation.

E. Audio/Visual Signaling Appliance (Speaker/Strobe)

1. Device color shall be red for wall mounted applications, and white for ceiling mounted applications.

2. It shall consist of a 4” voice evacuation speaker with multi-tap transformer with a UL1971/ADA Compliant Strobe. Strobe intensity to be provided as required by NFPA 72. Light intensities shown on drawings shall be used only as a basis for design. Field survey and adjust, if necessary, at no additional costs.

3. The speaker/strobe shall synchronized operation.

4. The unit shall be semi-flush mounted, if possible.

5. If the unit is to be surface mounted, install the matching backbox skirt provided by the equipment manufacturer. The surface backbox shall be a finished product. Painted 4” square electrical boxes shall not be permitted.

6. Provide 4” speaker support bracket for drop ceiling installations.

F. Remote Audio/Visual Signal Power Supply

1. The unit shall be 6A/24VDC, Addressable Charger/Power Supply with built-in signal synchronization modules.

2. The ACPS shall provide (5) fully addressable control inputs, one for each output circuit that are activated through the signaling line circuit in the fire alarm panel, one for synchronized horn input, and one monitor point for power supply trouble.

3. The use of separate addressable control modules, monitor modules, and synchronization modules shall be forbidden. Any fire alarm system that must be configured this way for proper operation is not acceptable.

4. It shall be possible to interconnect ACPS power supplies so that signal synchronization between power supplies can be provided.

5. The ACPS shall be mounted in cabinet with (2) 7AH to 25AH batteries. Secondary power supply shall provide for (24) hours of standby operation followed by (5) minutes of alarm operation.

6. All communications inputs to the ACPS from the fire alarm control panel, and all outputs from the ACPS to the fire alarm control panel, shall be accomplished over the fire alarm system signaling line circuit(s).

SECTION 5 – WIRING

5.1 INSTALLER'S RESPONSIBILITIES

A. The installer shall coordinate the installation of the fire alarm equipment with the manufacturer's authorized representative.

B. All conductors and wiring shall be installed according to the manufacturer's recommendations.

C. It shall be the Installer's responsibility to coordinate with the supplier, regarding the correct wiring procedures before installing any conduits or conductors.

5.2 INSTALLATION OF SYSTEM COMPONENTS

A. System components shall be installed in accordance with the latest revisions of the appropriate NFPA pamphlets, the requirements contained herein, National Electrical Code, local and state regulations, the requirements of the fire department, and other applicable authorities having jurisdiction (AHJ).

B. All wiring shall be type FPLP for plenum installations. All fire alarm cable shall be installed above the acoustic ceiling or contained in building walls. Where a device is mounted on a masonry wall, install conduit stub within wall from device backbox to top of wall. All wiring shall be concealed and all backboxes recessed. Where wiring cannot be concealed, install cables in EMT (Mechanical spaces) conduit. Where device backbox cannot be recessed in walls, provide the manufacturer's matching surface backbox.

C. Where wiring is run above acoustic ceiling, crawl spaces and pipe tunnels install cables in bridle rings connected to building steel supports. Install bridle ring every 6 feet. Cables shall not be ty-rapped to any pipes.

D. For fire alarm use, wire and cable shall be U.L. listed and be plenum rated, type FPLP.

E. Raceway containing conductors identified as "Fire Protective Alarm System" conductors shall not contain any other conductors and no AC current carrying conductors shall be allowed in the same raceway with the DC fire alarm detection and signaling conductors.

F. It shall be the responsibility of the contractor to coordinate the exact location of all installed equipment with all applicable trades.

G. Smoke and/or heat detectors shall be located 3 or more feet from any supply or return air register. Coordinate with mechanical contractor prior to final installation.

5.3 SPARE EQUIPMENT

A. The Electrical Contractor shall furnish up to ten (10) 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.

SECTION 6 – ADDITIONAL SERVICES, GUARANTEE AND FINAL TEST

6.1 GENERAL

A. The contractor shall guarantee all equipment and wiring to be free from inherent mechanical and electrical defects for one (1) year (365 days) from the date of final acceptance.

B. In addition to the equipment shown on the project drawings, and as stated above include twenty (20) 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.

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.

6.2 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 one (1) year (365 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.

6.3 AS BUILT DRAWINGS, TESTING, and MAINTENANCE INSTRUCTIONS

A. <u>As Built Drawings</u>

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>

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. Testing Frequency Instructions

1. Complete, accurate, step-by-step testing instructions giving recommended and required testing frequency of all equipment, methods for testing each individual piece of equipment, and a complete trouble-shooting manual explaining how to test the primary internal parts of each piece of equipment shall be delivered to the owner upon completion of the system.

2. Maintenance instructions shall be complete, easy to read, understandable, and shall provide the following information:

   - Instruction on replacing any components of the system, including internal parts.
   - Instructions on periodic cleaning and adjustment of equipment with a schedule of these functions.

A complete list of all equipment and components with information as to the address and phone number of both the manufacturer and local supplier of each item.

3. User operating instructions shall be provided, and prominently displayed on the cabinet front or on a separate sheet located next to the fire alarm control unit, in accordance with UL Standard #864.

END OF SECTION 280721

SECTION 280724: AREA RESCUE SYSTEM

PART 1 – GENERAL

1.1 GENERAL

A. The Contractor shall furnish and install all equipment including, but not limited to, outlet boxes, conduit (with pull strings), 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 Time Recorder Co. shall be considered as meeting these specifications and as the base bid. Any alternate system must be approved by the specifying authority. Bidders supplying an alternate system must make the authority aware of their intentions and provide adequate information, including catalog cuts, working and shop drawings, and a demonstration of the proposed system at least 10 days prior to bid date. Any prior approval of an alternate system does not exempt the supplier from meeting the intent of these specifications. If the alternate system fails to provide all the requirements specified in this document, the Contractor shall be responsible for all costs associated with the removal and replacement of said equipment.

1.2 ACCEPTABLE MANUFACTURERS

Simplex
Cornell
Housing Devices

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 280724

SECTION 280725: INTRUSION DETECTION SYSTEM

PART 1 – GENERAL

1.1 WORK INCLUDED

A. Provide all labor, materials, equipment, and services to perform all operations required for the complete installation and related work as shown in all contract documents.

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 SECURITY ALARM SYSTEM MANUFACTURER

A. The control/communicator, control stations, and programmers shall be manufactured by Detection Systems, Inc. as provided by Delmarva Systems Corporation, Newport Delaware.

1.4 SUBMITTALS

A. Submittals are required for the entire system, including the branch-wiring diagram.

1.5 SYSTEM DESCRIPTION

A. The actuation of any alarm initiating device shall cause the following to happen:

1. All audible security alarm annunciators shall sound. These annunciators shall be sirens.

2. Centrally located visual annunciation shall take place at a control station showing the particular point in alarm.

3. A telephone line shall be provided for communication to the alarm company central station.

4. All automatic locking devices located at each perimeter door, and all hatches or other access routes leading outside of the protected area shall automatically activate. The locking devices shall not be released except by the system operator at a master control panel, or automatically in the event of a fire alarm.

B. A code (personal identification number) shall be provided through the control station to manually silence all audible alarm signals.

C. The control/communicator shall contain initiating and bypass circuits as required, and shall be connected to all necessary equipment to individually and collectively power and effect the operating of the overall security alarm system. All initiating circuits shall be supervised.

D. The control station shall visually annunciate alarm and trouble conditions.

E. Remote access through the control station shall allow control of all options and functions of the control/communicator.

F. The control station shall provide panic keys that shall manually alarm the security alarm system.

G. Activation of any installed control station shall allow designated personnel an installer adjustable pre-set entry/exit delay time interval to enter or exit a secured area before alarming the system.

H. The control/communicator shall be connected to a primary source of 120 volts, 60Hz, through a U.L. Listed 18.0 VAC transformer rated at 50 VA. The control/communicator, in turn, shall then provide up to 2.5 A of power at 12.0 VDC nominal for the security alarm system's supervisory and detection functions.

I. Sufficient standby power shall be furnished for no less than four hours of overall system operation at full auxiliary power standby load of 1.5 A and 2.5 A total in alarm.

J. The control/communicator shall be installed in accordance with NFPA 72, The National Fire Code and in accordance with U.L. Standard UL864, Commercial Fire Alarm, Police Station Connection Grade A U.L. standard 1610, Central Station Burglary Alarm Grades B and C.

K. The alarm contractor shall provide all power supplies, peripheral devices, and equipment required for a complete and operational security alarm system.

PART 2 – PRODUCTS

2.1 CONTROL/COMMUNICATOR

A. The control/communicator shall be surface mounted, and contain all necessary system power and all circuitry shall be housed in a locked 20 Gauge cold-rolled steel enclosure.

B. The control/communicator shall supply standby power to operate the audible security alarm system's annunciators in the event of an alarm.

C. The control/communicator standby power shall be provided by rechargeable sealed lead-acid battery.

D. The control/communicator shall be capable of recharging the standby battery within 24 hours on a fully loaded system after the re-application of AC power.

E. Auxiliary power shall be 12.0 VDC nominal at up to 1.5 A continuous to power auxiliary devices and shall not be battery dependent.

F. The temperature compensated battery charge shall be for up to 34.4 AH of batteries.

G. Circuitry shall be protected by MOVs or the equivalent, backed-up by spark gaps, and shall have automatically resettable thermal breakers.

H. Each installed control station shall allow system arming, disarming, bypassing, and shall display the status of the security alarm system.

I. The control/communicator shall have the following outputs:

1. The alarm output shall be controlled by a 12.0 VDC, form A, 1.0 A contact connected to auxiliary power. It shall be able to be programmed for a steady or pulsed output.

2. The programmable output #1 shall be a solid state current sink rated at 1 A max. It shall be able to be used for alarm, arming state, or access control, and shall be generally programmable.

3. The programmable output #2 shall be a solid state voltage source rated at 500 MA. max. It shall be able to be used for alarm, arming state, or access control, and shall be generally programmable.

J. The control/communicator shall have 8 (expandable to 128) supervised normally open or normally closed burglar input points.

K. The control/communicator shall be capable of being divided in up to eight partitions. This shall allow the system to act as up to eight different and independent systems. Each partition shall have an individually programmable automatic arming time. This automatic arming time shall be extendable on a per day basis using a PIN number followed by a special command.

L. The control/communicator shall be capable of having a common area when more than one partition exists in the system. The common area shall be partition one, and it shall be able to be common to all other partitions (allowing for use of a common entry way to other partitions). The common area shall arm only when all the partitions it is common to are armed. It will disarm when any of the partitions it is common to are disarmed, only if the user has access to the common area.

M. Up to 15 control stations shall be able to be connected to the control/communicator. These control stations shall be able to operate the security alarm system and fully program the control/communicator.

N. Any or all of the control stations shall be capable of being a master control station. It shall be capable of accessing all partitions. It shall display the arm/disarm status of all the partitions and can be used to individually control each partition. It shall be able to be assigned to any or all of the partitions.

O. The control/communicator shall contain a history buffer that shall retain the last 400 events by time and day. The most recent 64 events shall be stored in a non-volatile memory and will be kept even in the event of total power loss. It shall be able to be read back through any control station.

P. The control/communicator shall have non-volatile EEPROM memory that is unaffected by a power failure.

Q. The control/communicator shall be remotely accessible with remote programming software, using an IBM compatible PC and a Hayes brand modem. This accessibility shall allow control of all system programming.

R. The control/communicator shall be capable of answering a call from a remote programmer, hanging up and calling the remote programmer back, preventing access to the control/communicator by foreign remote programmers.

S. The control/communicator shall be capable of reporting to up to two 20 digit phone numbers with full single, double, and back-up reporting. It shall communicate in 3/1, 3/1 extended, 3/1 with parity, 3/1E with parity, 4/1, 4/2, BFSK, SIA 110 Baud, SIA 300 Baud, Pager and Contact ID formats.

T. The control/communicator shall be capable of sending all alarm, restoral, trouble, opening, closing, cancel, and test reports to a digital receiver.

U. The control/communicator shall dial out on tone or pulse, and loop start or ground start phone lines. Tone dial shall revert to pulse dial when required.

V. Up to 90 personal identification numbers with seven authority levels shall operate the security alarm system and shall be capable of reporting to a digital receiver uniquely by number.

W. The operating temperature range of the control/communicator shall be +32° to +120°F (0° to+49°C).

X. When using the expansion points, a BusLoc® code shall be available which will help prevent system takeover by programming an invisible identification code into each multiplex point.

Y. Control panel shall be a Detection Systems, Inc. DS7400Xi.

2.2 CONTROL STATION

A. The control station shall contain a keypad, sounder, and status indicator lights (armed, status, and power) with an alphanumeric read-out display.

B. The control station shall have a back-lit keypad. Text for alphanumeric displays shall be freely programmable for all points and partitions.

C. A control station shall support all of the control/communicator functions.

D. Any or all of the control stations shall be capable of being a master control station. It shall be capable of accessing all partitions. It shall display the arm/disarm status of all the partitions and can be used to individually control each partition. It shall be able to be assigned to any or all of the partitions.

E. The control station shall be connected to the control/communicator with #22 AWG, unshielded, 4-wire cable and have a maximum of 1000 feet between the control/communicator and the control station.

F. The control station shall be capable of complete system programming by inputting an installer changeable personal identification number.

G. The control station shall allow the following four levels of arming:

1. The entire system shall be armed with exit points programmed for delays.

2. The entire system shall be armed with entry and exit points programmed for delays.

3. The perimeter points shall be armed without delays and the interior points shall not be armed.

4. The perimeter points shall be armed and programmed for entry and exit delays and the interior points shall not arm.

H. Arming and disarming the security alarm system shall be done by entering a user personal identification number.

I. Arming the alarm security system shall initiate a programmable 0-99 second exit delay on points programmed for delays. The red ‘armed’ light shall flash, then go on steady after the exit delay has been completed.

J. Entering a protected area through a delay point, when the system is armed, shall initiate a 0-99 second entry delay, and the pre-alert tone shall sound. Disarming the system before the entry delay expires shall silence the pre-alert tone.

K. Entering a protected area through a delay point, when the system is armed, and an alarm had occurred while the system was armed, the red “armed” light shall flash during the entry delay. Entering a personal identification number shall disarm the system and shall stop the light from flashing.

L. There shall be a mode to custom arm the system. This mode shall be able to be programmed to arm any combination of point functions.

M. Bypassing points or force arming the security alarm system shall be done at the control station when the green 'status' light is off, indicating one or more points are not ready to arm.

N. The following tests shall be able to be performed by inputting a key command at the control station while in the disarm mode:

1. A burglar point test shall begin scrolling the point numbers of those burglar points that are untested (unviolated). While a point is being tested (violated) it will appear on the control station display and the sounder will turn on. When that point is done sounder will turn off and the display will return to showing those points remaining to be tested.

2. A fire point test shall begin scrolling the point numbers of those fire points that are untested (unviolated). While a point is being tested (violated) it will appear on the control station display and the sounder will turn on. When that point is done being tested, the sounder will turn off and the display will return to showing those points remaining to be tested.

3. The local battery/sounder test shall operate the control station sounders alarm outputs for two seconds while load testing the battery.

4. The battery test shall check the battery voltage while the full system or alarm load is applied.

5. The communicator test shall initiate the control/communicator to send a pre-programmed report to a digital receiver. A duress signal shall be sent to a digital receiver when disarming the security alarm system using a duress code. The system will appear to disarm normally with no indication that a duress signal has been sent.

P. The control station shall provide fire, emergency, and panic keys that shall manually and immediately alarm the system. They shall be recessed into the keypad cover to prevent accidental activation.

Q. The control station shall be capable of surface mounting. It shall be capable of being mounted to single or four gang switch or outlet boxes.

R. The control station shall include six function buttons to facilitate common system commands. These buttons shall be labeled ON to arm the system, OFF to disarm the system, PERIMETER ONLY, to arm only the perimeter, NO ENTRY to disable the entry delay period, BYPASS, to disable a point, and SYSTEM RESET to reset system trouble conditions and latched smoke detectors.

S. LCD Keypad shall be a Detection Systems, Inc. DS7447.

2.3 REMOTE PROGRAMMER

A. The remote programmer shall operate with an IBM compatible computer that is equipped with a Hayes brand modem and running Windows 3.1, Windows 95 or higher.

B. The remote programmer shall support color or monochrome monitors, and shall allow selection of menu items, data, and help using a mouse or other pointing device.

C. The remote programmer shall remotely access the control/communicator and allow access and notification to all system options, status, and programming.

D. Unattended uploading, downloading, arming, disarming, bypassing, and testing shall be capable with the remote programmer.

E. An account shall be created for each control/communicator that is connected by the remote programmer and shall be capable of being logged and located by phone numbers, names, addresses, account numbers, and sort keys.

F. There shall be up to 15 authority levels which can restrict remote programmer users access to certain information and options.

G. The remote programmer shall allow up to 100 default files to be created which serve as templates for formatting common characteristics of similar accounts.

H. User formatted reports containing any data base items or history event can be printed or exported to other programs.

I. The remote programmer shall be capable of locking out all or partial control station programming.

J. A unique, one of one trillion combination security code can be downloaded to the control/communicator, limiting access to a particular remote programmer.

K. The remote programmer shall be a Detection Systems, Inc. WDSRP

2.4 ACCESSORIES

A. The DS7420iAT: Dual Phone Line/Bell Supervision Module. This module shall allow the control/communicator to be used in NFPA 72 installations. It shall connect to the options bus of the control/communicator. It shall provide two supervised 12.0 VDC signaling outputs, dual phone line transmission and supervision, and an Auxiliary output supervision jumper. One DS7420iATmodule shall be allowed per system.

B. The DS7430: Multiplex Expansion Module. This module shall allow the control/communicator to expand to 128 points. It shall connect to the expansion port of the control/communicator. It shall provide a bus power output for the connection of separately powered multiplex devices. One DS7430 module shall be allowed per system.

C. The DS7432: Eight Input Remote Module. This module shall provide a means of addressing up to eight input loops of conventional contacts to the multiplex bus of the control/communicator. This module requires the use of the DS7430. Up to fifteen DS7432 modules shall be allowed per system.

D. The DS7450: Flush Mount Single Multiplex Contact Point. This module shall monitor a single flush mount magnetic contact and is intended as a replacement for conventional dry contacts. The module connects to the DS7430 Multiplex Expansion Module.

E. The DS7452: Surface Mount Single Multiplex Contact Point. This module shall monitor a single surface mount magnetic contact and is intended as a replacement for conventional dry contacts. The module connects to the DS7430 Multiplex Expansion Module.

F. The DS7457: Single Zone Multiplex Input Module. This module shall monitor a single set of conventional normally open or normally closed dry contacts. The module connects to the DS7430 Multiplex Expansion Module.

G. The DS7460: Dual Point Module. This module shall monitor conventional normally open or normally closed contacts and will report their status to the control/communicator as multiplex addresses. The module will occupy two multiplex points on the system and can monitor up to two separate loops. The module connects to the DS7430 Multiplex Expansion Module.

H. The DS7465: Single Input/Output Module. This module shall monitor a conventional normally open or normally closed dry contacts and will report their status to the control communicator as a multiplex address. This module shall also provide a single normally open or normally closed dry

contact as a programmed output. The module shall occupy two multiplex zones and no more than 20 modules are allowed per system. This module connects to the DS7430 Multiplex Expansion Module.

I. The DS7488: Octal Relay Module. This module shall provide eight form “C” relay outputs for addition to the control/communicator. It shall connect to the options bus of the control/communicator. The outputs shall be fully programmable and shall be activated by several system events. Each output shall operate individually of the other seven outputs for complete flexibility. Two DS7488 modules shall be allowed per system.

J. The MX835: TriTech Microwave/PIR Intrusion Detector. This module provides a coverage range of 35 by 35 feet (10.7 by 10.7 meters) and features Detection Systems “Pet Avoidance” technology. This module connects to the DS7430 Multiplex Expansion Module and requires an external voltage of 9-15 VDC at a maximum of 35 mA.

K. The MX950: TriTech Microwave/PIR Intrusion Detector. This module provides a coverage range of 50 by 50 feet (15 by 15 meters) and features Detection Systems motion monitor and anti-mask technology. This module connects to the DS7430 Multiplex Expansion Module and requires an external voltage of 9-15 VDC at a maximum of 35 mA.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Installation shall be accomplished in a professional manner by qualified personnel regularly engaged in and experienced in this type of work.

B. Install all wiring in accordance with manufacturer’s recommendations.

C. All wiring shall be stranded copper and installed in accordance with NEC open wiring requirements, EMT conduit as a separate and segregated system.

D. Provide #18 AWG four-conductor cable as recommended by the equipment supplier. Minimum #14 AWG for audible devices.

E. Provide a dedicated 120-volt circuit in separate conduit as a source of primary power for the master control/communicator.

F. Supply, install, and recommended transformers and DC power sources to the master control/communicator. For use with the control/communicator, the transformer shall be dedicated, and shall be Detection Systems, Inc. Model TR-18C. The transformer shall not be shared with anything else.

G. Perform walk tests and set-up procedures for each detector as specified by the manufacturer to ensure that all boundaries of coverage are sufficient to detect intruders in each secured area.

H. The alarm contractor shall provide complete wiring diagrams to the electrical contractor as part of the shop drawing submittal, and shall supervise the installation in order to ensure a complete operating and trouble-free system.

I. Provide three (3) sets of keys for all panels, stations, and devices.

3.2 TESTING

A. The alarm contractor shall submit a written test report that the system has been 100 percent tested and approved. The final test shall be witnessed by the Owner and performed by the alarm contractor. The final test report must be received and acknowledged by the Owner prior to request for final payment.

B. Provide instruction to the Owner's satisfaction with regard to proper use and operation of the system.

END OF SECTION 280725

SECTION 280727: INTEGRATED ACCESS CONTROL & SECURITY MANAGEMENT SYSTEM

PART I – GENERAL

1.1 This specification is a basic description of the Card Access System. This Contractor shall be responsible for the expansion of the existing District-wide system to cover this building.

A. General Description:

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.

The SMS shall provide extensive information management capability using Microsoft .NET Framework V3.0. 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 128 simultaneous clients, multiple types of controllers, and over 10,000 input devices, including cameras and multiple types of card readers. The SMS shall use MS SQL Express, MS SQL Server 2005 or Oracle 10g Databases for data protection, redundancy and manageability.

The SMS shall have true multi-tasking and remote terminal capability; 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.

Field devices such as card readers, alarm inputs, control points, etc. shall be connected to fully distributed intelligent field controllers 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

Prior to assembling or installing the SMS, the Contractor shall provide complete shop drawings which include the following:

1. Architectural floor plans indicating all system device locations.
2. Full schematic wiring information for all devices. Wiring information shall include cable type, cable length, conductor routings, quantities, and point-to-point termination schedules.
3. Complete access control system one-line block diagram.
4. Statement of the system sequence of operation.
5. Riser diagrams showing interconnections.
6. Detail drawings showing installation and mounting.
7. Fabrication drawings for console arrangements and equipment layout.

All drawings shall be fully dimensioned and prepared in DWG format using the latest version of AutoCAD.

B Product Data

Prior to assembling or installing the SMS, the Contractor shall provide the following:

1. Complete product data and technical specification data sheets that includes 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.

2. 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:

   a. Central processor configuration and memory size
   b. Description of site equipment and its configuration
   c. Protocol description
   d. Rigid disk system size and configuration
   e. Backup/archive system size and configuration
   f. Start up operations
   g. System expansion capability and method of implementation
   h. System power requirements and UPS sizing
   i. A description of the operating system and application software.

C As-Built Drawings

At the conclusion of the project, the Contractor shall provide "as built" drawings. The "as built" drawings shall be a continuation of the Contractors 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 latest version of AutoCAD.

D Manuals

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:

1. Functional Design Manual

   The functional design manual shall identify the operational requirements for the system and explain the theory of operation, design philosophy, and specific functions. A description of hardware and software functions, interfaces, and requirements shall be included for all system operating modes.

2. Hardware Manual

   The hardware manual shall describe all equipment furnished including:

   a. General description and specifications
   b. Installation and check out procedures
   c. Equipment layout and electrical schematics to the component level
   d. System layout drawings and schematics
   e. Alignment and calibration procedures
   f. Manufacturers repair parts list indicating sources of supply

3. Software Manual

The software manual 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:

a. Definition of terms and functions
b. Use of system and applications software
c. Initialization, start up, and shut down
d. Alarm reports
e. Reports generation
f. Data base format and data entry requirements
g. Directory of all disk files

4. Operators Manual

The operator's manual shall fully explain all procedures and instructions for the operation of the system including:

a. Computers and peripherals
b. System start up and shut down procedures
c. Use of system, command, and applications software
d. Recovery and restart procedures
e. Graphic alarm presentation
f. Use of report generator and generation of reports
g. Data entry
h. Operator commands
i. Alarm messages and reprinting formats
j. System access requirements

5. 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

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 C•CURE 9000 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 (Pending)

2. The SMS shall be tested and listed by Underwriters Laboratories (UL) for UL/cUL 1076 for Proprietary Alarm Units (Pending)

3. The SMS shall employ a FIPS 197-listed AES 256-bit encryption between C•CURE 9000 Servers, Clients, and iSTAR eX 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 eX controller)

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. Digital Video Integration option

1.4 WARRANTY

The Security Management System (SMS) shall be provided with a 14 month product warranty from date of shipment or 1 year from date of registration, whichever is shorter. 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 Security Management System (SMS) shall be the Software House C•CURE 9000 system.

2.2 DESCRIPTION

A. The Security Management System (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, 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 PERFORMANCE

A Graphical User Interface (GUI)

The Security Management System (SMS) shall employ a standard Windows XP™ Professional, Windows 2003 Server, or later 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 ‘tree structure’ similar to Windows Explorer.

B 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 which 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.

C 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.

4. 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 in 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, to 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. A GUI that displays the images of personnel as they enter, as well as the stored images of personnel available in the SMS.
    h. Ability to view a sortable list of active alarms or events and recently active alarms or activity.
    i. 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.
    j. A GUI that minimizes the number of operator mouse clicks or keyboard strokes.
    k. Mouse controls include “right click” pop-ups and highlighted default selections.
    l. 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.
    m. 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.
    n. Allow the customization of columns as defined by the operator privilege, including:
        i. Adjusting width (on the fly or pre-programmed)
        ii. Not displaying Columns (on the fly or pre-programmed)
        iii. Sorting on selected columns (to follow standard Windows conventions)
    o. 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.

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.

5. The SMS shall support audible alarm annunciation at operator workstations (operator configurable audio (WAV) files associated with alarms).

6. 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. Manual Action command buttons
i. Pre-defined and configurable acknowledgement messages
j. Log message
k. Clear event
l. Clear group of events
m. Event action message (automatically display selected message for event)
n. Dynamic views

D 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. Operator 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:

a. AutoCAD (.DWG)
b. SVG
c. DXF
d. DWF
e. Windows Meta File (WMF)

f. TIFF (.TIF)
g. JPEG (.JPG)
h. PNG
i. Windows Bitmap (.BMP)
j. GIF

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. The Maps feature shall also include a tracking window, a magnification window, and a coordinate window.

E 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 restored and replayed.

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.

F 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 only.

2. The SMS shall support the use of Ethernet networks as the communications path between the host computer and field devices such as ETHERNET ISC, iSTAR 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.

G 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 Windows XP or Windows 2003 operating systems.

H 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 templates for all object classes. These templates shall be operator configurable to provide default values for data fields within an object class's configuration.

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 Windows single sign-on (SSO) that integrates login credentials with operator permissions to provide seamless user authentication and authorization.

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.

I 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.

J 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.

K Outputs

1. The SMS shall have outputs, also known as Control points that associate an input or event action with a relay. These output uses include doors / elevators, alarms and industrial control.

2. There shall be two types of outputs available: dry contact / Form C relays and Open Collectors. Outputs shall be configured such that they can be activated, deactivated or pulsed by system actions.

L Card and Reader Support

1. The SMS shall support configuration of unlimited card formats.

2. The SMS shall support up to 10 card formats per iSTAR reader.

3. The SMS shall support readers that provide Wiegand signaling and magnetic signaling to include:

    a. Wiegand swipe readers
    b. Proximity readers
    c. Biometric readers
    d. Smart card readers
    e. Wireless readers
    f. Magnetic readers

M 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 configuration of unlimited elevators.

N 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.

O 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.

P 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.

Q Clearances

1. The SMS shall support configuration of unlimited Clearances.

2. The iSTAR controllers shall support up to 40 clearances per person.

3. The SMS shall support clearance activation and expiration date and time.

R 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 a log message to be entered by the system operator responding to the event.
e. Display or not display the event activation.
f. Require the object(s) causing the event activation to reset before the operator may acknowledge the event.
g. Display an operator-defined text message upon event activation.
h. Display an operator-defined text message when the event is deactivated.
i. Be associated with a map so the map opens automatically on the monitoring station when the event activates.
j. Activate a second event when the first event activates and is unacknowledged for a specified period of time.
k. Allow the operator to associate an audio wave file with the event.
l. Allow for minimum activation time and delayed activation time for events.
m. Download events to the iSTAR controllers.
n. Run imports and exports
o. Run reports and remove report results

S Integrated E-mail

1. The e-mail system shall have the ability to interface directly to an SMTP-compliant e-mail system supplied and configured by the user.

T 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 provide a Data Mapper feature that provides field mapping information using the XSLT file based on the input data or an external XSLT file.

U 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.

V Reports

1. The SMS shall provide configurable data reports for database configuration, historical activity (Journal) and audit tracking.

2. 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 predefined 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.

W Dynamic Views

1. The system shall support a grid format displayable report which 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. 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.
g. The view shall be capable of pre-configuration so that repeatable displays of objects are possible.
h. The view shall support in-place editing of properties of the object.
i. 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.

X 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 user 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 user 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 supports complex logic, such as AND/OR.

Y CCTV Integration / Digital Video

1. The SMS shall provide comprehensive integration with American Dynamics Intellex digital video recorders through the use of NetVue.

2. The SMS server shall be connected to the DVR during the configuration process enabling the SMS to query the DVR 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.

7. The SMS shall provide the ability to interface with IP cameras.

Z. System Parameters

1. The Security Management System (SMS) shall have a minimum capacity of:

- 16 online readers
- 64 online inputs
- 64 online outputs
- 7,000 credentials
- 6 simultaneous Clients
- 1 Badging Client

2. The SMS shall have a maximum capacity of:

- 2,500+ online readers
- 10,000+ online inputs
- 10,000+ online outputs
- 500,000 credentials
- 256 simultaneous Clients
- 10+ Badging Clients

2.4 OPERATION

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 iSecure, C·CURE 800/8000 and 3rd party applications via XML formatted data exchange.

2.5 EQUIPMENT

A Server Requirements (provided as part of base bid by School District)

The SMS server shall meet the following minimum requirements:

1. The server shall have an Intel Pentium IV / Xeon processor (3.4 GHz or better) with either single or dual 64 bit CPU's.
2. The server shall have 4 GB RAM.
3. The server shall have dual 100 GB hard disk drives at 7200 RPM.
4. The server shall have a CD / DVD combo drive.
5. The server operating system shall be Windows 2003 Enterprise Server, 32 bit native mode, with Service Pack 1 or later and default services enabled.
6. The Web Server shall be IIS 6.0 or better.
7. The Database shall be SQL Server 2005 Express Edition (SQL Express) for fewer than 10 controllers and SQL Server 2005 Standard Edition (SQL Server 2005) for 10-15 controllers.
8. The server shall have a 17" or larger SVGA (1024 x 768) monitor with true color support for badging.
9. The server shall have a dedicated 256 MB SVGA accelerated video card with at least 64 MB onboard RAM.
10. The server shall have a 1 GB NIC or larger network card, rated at 100/1000 MB/sec.
11. The server shall have a PS/2 or USB style mouse.
12. The server shall have an appropriate backup device.

B Controllers

The SMS shall support the following controller hardware:

1. Software House iSTAR Pro
2. Software House iSTAR eX

PART 3 EXECUTION

3.1 TESTING

1. 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.

2. 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.

3. 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.

4. 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

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 alternate, the Contractor may propose the use of factory training personnel and coordinate the number of personnel to be trained.

3.3 MAINTENANCE

1. The Contractor shall offer a Software House Software Support Agreement (SSA) in order for Software House Technical Support Specialists to reactively troubleshoot system problems.

2. 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.

3. As part of the agreement, Flashable and Non-Flashable (Chips) firmware and documentation shall be provided.

4. As part of the agreement, access to C•CURE patches and software release updates shall be provided.

5. The SSA shall cover the current C•CURE 9000 release one full version back, and associated controller hardware.

END OF SECTION 280725

SECTION 311000
SITE CLEARING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Site Clearing shall consist of clearing of the site within the limits of disturbance to include the following:

1. Removal and disposal of trees and brush, weeds, roots, and similar materials.
2. Removal and disposal of civil structures, paving, base course, utilities, concrete sidewalks and aprons, and all other obstructions which are designated on the Plans for removal during construction.
3. Topsoil stripping and stockpiling.
4. Saw-cutting existing concrete and paved surfaces.
5. Protection of existing utilities and adjacent property, structures, benchmarks, and monuments.

1.2 STANDARDS

A. The quality and performance of work specified in this section shall be in accordance with the Delaware Department of Transportation Standard Specifications for Road and Bridge Construction, dated August 2016, latest revision (hereinafter referred to as the “Standard Specifications”).

1. Section 201: Clearing and Grubbing
2. Section 211: Removal of Structures and Obstructions and Existing Portland Cement Concrete Pavement, Curb, and Sidewalk
3. Section 762: Saw Cutting and Butt Joints

1. 3 PHASING

A. Site clearing shall be performed prior to the grading and stripping operations, within the limits of grading, as indicated on the drawings and as specified herein. Following clearing, topsoil shall be stripped and stored for later use on the site or disposition by the Owner.

1.4 PROTECTION

A. The Contractor shall protect all trees, shrubs, ground plants, roads, walks, pavements, structures, civil improvements, and appurtenances not indicated to be cleared from the site. Methods of protection shall be by use of substantial wood or chain link fences, barriers, or other methods, as approved by the Engineer. Any trees, shrubs, ground plants, roads, walks, pavements, structures, or appurtenances indicated to remain that become damaged during construction of the project shall be repaired or replaced by the Contractor, as directed by the Engineer, at no additional cost to the Owner.

B. The Contractor shall contact all utility companies to mark the location of their facilities. The Contractor shall protect all existing utilities in place and maintain continuous service to the Owner. Any damage to the utilities shall be corrected by the Contractor at his expense. The Contractor shall also be responsible for coordinating and/or relocating any utilities which must be relocated to accommodate the proposed construction.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All materials shall be at the Contractor's option, subject to the approval of the Engineer.

PART 3 - EXECUTION

3.1 CLEARING AND GRUBBING

A. Clearing shall consist of the removal of all trees and shrubs, brush, down timber, rotten wood, heavy growth of grass and weeds, vines, rubbish, walks, roads, curbs, walls and foundations, existing utilities already abandoned, and all objectionable debris. All walls, foundations, slabs, pavements, curbs, and footings shall be removed to their full depth.

B. Grubbing shall consist of the removal of stumps, roots, root mats, stubs, buried logs, and other debris within the project limits. The Contractor shall remove all stumps and root mats in their entirety and all buried logs and other debris from within building areas and from the limits of proposed drives and walks. Within proposed lawn areas, stumps, roots and debris shall be removed to a minimum depth of one foot below design rough grade.

C. Construction methods shall be in accordance with Sections 201 and 211 of the Standard Specifications.

3.2 DISPOSAL OF REMOVED MATERIALS

A. All timber and cleared materials shall become the property of the Contractor, and shall be disposed of by the Contractor. Burning and/or burial of materials on site is prohibited.

B. Pavement, base course, concrete, utilities, and other obstructions shall be removed from the site and shall be disposed lawfully. The Contractor shall provide evidence of the lawful disposal when requested by the Owner or the Owner’s Representative.

3.3 SALVAGED MATERIALS

A. Materials listed to be salvaged for reuse shall be stored by the Contractor in such a manner to prevent damage to the material. Salvaged materials which are not reused shall be disposed of lawfully by the Contractor unless the Owner specifically requests to take possession of the material.

3.4 STRIPPING AND STORING TOPSOIL

A. Topsoil shall be considered to mean original surface soil, typical of the area, which is capable of supporting native plant growth.

B. All topsoil suitable for reuse, in the opinion of the Engineer, shall be stripped to its full depth, and stockpiled.

C. Topsoil stripping shall be accomplished from all topsoiled areas to be disturbed.

D. Heavy strands of weeds and grasses shall be removed or turned over, as directed by the Engineer, prior to the stripping operations.

E. The topsoil shall be kept separate from the excavated material and stored in stockpiles, the location of which shall be as directed by the Engineer. Topsoil shall be stockpiled so that it shall not be subject to abnormal erosion and loss, and it does not impede the flow of drainage runoff. Topsoil shall be stockpiled in the location sown on the Plans or as approved by the Engineer.

3.5 SITE DEMOLITION

A. Remove walks, roads, curbs, walls and foundations, existing utilities already abandoned, and all objectionable debris. All walls, foundations, slabs, pavements, curbs, and footings shall be removed to their full depth.

B. Procure all permits required for demolition and disposal. Coordinate utility work with utility companies and subcontractors. All debris shall be removed and disposed lawfully.

C. Where applicable, brace and shore all portions of the existing structure for safety and to maintain the integrity of the existing building. Provide protection for the general public. Disconnect all utilities prior to demolition in areas where live utilities may be located.

3.6 SAW-CUTTING

A. Mechanically saw cut patch edges or tie-in joints into existing paving or sidewalk using a concrete cutting machine with a suitable motor-driven diamond blade and a circular cutter unless otherwise approved by the Engineer.

B. Saw-cut grooves shall be straight lines to a sufficient depth so that an even, neat joint can be cut to allow removal of material without damage to the adjacent pavement, sidewalk, or curb. A continuous water supply shall be supplied to the cutting blade.

END OF SECTION

SECTION 312000
EARTHMOVING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide labor, materials, and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Filling and backfilling to attain indicated grades.
2. Excavation, rough and finish grading.
3. Furnishing and installing graded aggregate base course material for pavements, hot-mix patches and other structures.
4. Undercut excavation and furnishing graded aggregate base course for undercut excavation.
5. Furnishing excavation support systems, as required, including shoring and bracing.
6. Excavation for trenches.
7. Preparing topsoil stripped from the site and placing topsoil in locations requiring seeding or sodding.
8. Furnish Compost Stormwater Blanket.

B. Definitions

1. Excavation: removal and disposal of all material encountered when establishing required grade elevations, including pavements and other obstructions visible on the ground surface, and underground structures and utilities indicated to be demolished and removed, and unsuitable subgrade material.
2. Unauthorized excavation: Removal of materials beyond specified subgrade elevations without approval of a Geotechnical Engineer.

1.2 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies

1. All excavations shall be in compliance with Federal Occupational Safety and Health Act.
2. Excavation work shall be in compliance with application requirements of other governing authorities having jurisdiction.

B. Standards

1. Refer to the following sections in the Delaware Department of Transportation Standard Specifications for Road and Bridge Construction, dated August 2016, latest revision. (Hereinafter referred to as the "Standard Specifications")

Section 202:	Excavation and Embankment
Section 207:	Structural Excavation and Backfill
Section 209:	Borrow
Section 301:	Graded Aggregate Base Course
Section 302:	Stone
Section 908:	Soil Stabilization Practices

Section 1001: Borrow
Section 1004: Coarse Aggregate
Section 1005: Graded Aggregate

2. American Society for Testing and Materials (ASTM);

   D-1556: Density and Unit Weight of Soil in Place by the Sand-Cone Method.
   D-1557: Laboratory Compaction Characteristics of Soil Using Modified Effort
   D-698: Laboratory Compaction Characteristics of Soil Using Standard Effort
   D-4253: Maximum Index density and Unit Weight of Soils Using Vibratory Table
   D-2166: Unconfined Compressive Strength of Cohesive Soil
   D-6938: In-Place Density and Water Content of Soil and Soil Aggregate by Nuclear Methods (Shallow Depth)

3. Delaware Erosion and Sediment Control Handbook dated April 2016

4. U.S. Composting Seal of Testing Assurance (STA) program.

1.3 SUBMITTALS

A. Material Certification and delivery slips for:

   1. Select Borrow
   2. Graded Aggregate Base Course
   3. Delaware #57 Stone
   4. Compost Stormwater Blanket

1.4 JOB CONDITIONS

A. Existing Utilities

   1. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult the Utility Owner immediately for directions. Cooperate with the Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility Owner.
   2. Do not interrupt existing utilities serving facilities occupied and used by the Owner.
   3. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies for shut-off of services if lines are active.

B. Use of Explosives: The use of explosives is not permitted unless approved by a Geotechnical Engineer.

C. Protection of Persons and Property

   1. Barricade open excavations occurring as part of this work and post with warning signs as required to protect persons on the site.
   2. Protect trees, shrubs, lawns and other features remaining as part of final landscaping.
   3. Protect structures, utilities, sidewalks, pavements and other facilities from damage caused by settlement lateral movement undermining, washout and other hazards created by earthwork operations.
   4. In the event of damage, immediately make all repairs and replacements to the approval of the Owner, at no cost to the Owner.

D. Dust Control

1. Use all means necessary to control dust on and near the work if such dust is caused by the Contractor's operations during performance of the work or if resulting from the conditions in which the Contractor leaves the site.
2. Thoroughly moisten all surfaces as required to prevent dust being a nuisance to the public, neighbors and concurrent performance of other work on the site.

E. Weather Conditions: Do not place, spread, or roll fill material during freezing, raining, or otherwise unfavorable weather conditions.

PART 2 - PRODUCTS

2.1 GENERAL

A. For approval of borrow materials, at least five (5) working days in advance of intention to import material, designate the proposed borrow area, and provide samples to prove the quality and suitability of the material.

2.2 ON-SITE FILL

A. All on-site materials used for fill shall be acceptable to a Geotechnical Engineer and shall be minimally subject to the following requirements:

1. Free from deleterious substances, stumps, brush, weeds, roots, sod, rubbish, garbage and matter that may decay.
2. Free of large rocks or lumps that may create voids or prevent proper compaction.

2.3 BORROW FILL MATERIAL

A. Free from deleterious substances, stumps, brush, weeds, roots, sod, rubbish, garbage and matter that may decay, and shall be Borrow Type "C" conforming to Section 1001 of the Standard Specifications. All suitable excavated material, which meets the requirements of Section 1001 of the Standard Specifications shall be used for borrow fill material, except as otherwise stated in the plan of remedial action.

2.4 TRENCH AND CIVIL STRUCTURE BACKFILL MATERIAL

A. Backfill for civil structures shall conform to the requirements of Section 209 of the Standard Specifications.

B. Backfill for trenches shall conform to the requirements of Section 209 of the Standard Specifications.

C. All trench and civil structure backfill material shall meet the requirements of Section 1001 of the Standard Specifications for Borrow Type C backfill. All suitable excavated material, which meets the requirements of Section 1001 of the Standard Specifications shall be used for structure or trench backfill as far as practicable.

2.5 GRADED AGGREGATE BASE COURSE

A. Graded Aggregate base course for bituminous and concrete pavements and other structures shall be Type "B" conforming to the requirements for Graded Aggregate in Sections 301 and 1005 of the Standard Specifications.

2.6 TOPSOIL

A. Topsoil furnished from within or outside the project limits shall conform to Section 908 of the Standard Specifications except as modified by the following requirements.

1. Topsoil shall not contain stones, lumps, roots or other objects larger than one inch in any dimension.
2. Acid-Alkaline Range: pH 6.0 to 7.5.
3. Free of pests, pest larvae, and matter toxic to plants.
4. Maximum soluble salts: 500 ppm
5. Free of viable Bermudagrass, quackgrass, Johnsongrass, nutsedge, poison ivy, Canada thistle, and other objectionable grassy or broadleaf weeds.

B. Topsoil Furnished from Outside Project Limits

1. Gradation range:
   Sand (2.00 mm to 0.05 mm) 40-80 percent
   Silt (0.050 mm to 0.005 mm) 10-30 percent
   Clay (0.005 mm and smaller) 10-30 percent

   a. When one-half of the sand content is larger than 0.500 mm, the maximum sand content shall be seventy-five percent; and maximum clay content shall be fifteen percent.
   b. Lower limits of silt and clay shall be flexible to extent that soils with minimum combined silt and clay content of twenty percent shall be satisfactory. However, if more than one-half of the sand is larger than 0.50 mm., then minimum clay content shall be fifteen percent, or the minimum combined silt and clay content shall be twenty-five percent.

2. Organic content:

   a. Minimum of 1.5 percent by weight.
   b. If necessary, add peat at the rate necessary to attain minimum organic content.

C. Topsoil Placed within Multipurpose Field

1. In addition to the requirements above, topsoil placed within the proposed Muilti-Use area shown on the Plans, shall not contain stones, lumps, roots or other objects larger than one half inch in any dimension.

2.7 COMPOST STORMWATER BLANKET

A. Compost Stormwater Blanket shall contain compost conforming to the compost material properties as described in Appendix 6 of the Delaware Erosion and Sediment Control Handbook dated April 2016 and being provide by a member of the U.S. Composting Seal of

Testing Assurance (STA) program. Blanket shall be as manufactured by Eastern Shore Forest Products, Inc., Holland Mulch, Inc., Laurel Valley Soils, Inc., or approved equal.

PART 3 - EXECUTION

3.1 INSPECTION BY CONTRACTOR

A. Examine the areas and conditions under which excavating, filling and grading are to be performed. No extra cost or time allowances will be granted for conditions existing and visible at the time of the bid opening.

3.2 PREPARATION

A. Prior to commencement of work, establish location and extent of all utilities in the work areas. Maintain and protect, as required, existing utilities which pass through the work area.

B. Prior to excavation in pavement areas, saw cut existing pavement in accordance with Section 762 of the Standard Specifications.

3.3 EXCAVATION

A. Unauthorized Excavation

Unauthorized excavation shall not be at the Owner's expense. Under roadways and pipes, fill unauthorized excavation by removing all loosened material and providing select material as required to attain a firm and unyielding subgrade and/or foundation and to attain required grade elevations.

B. Rock Excavation

Rock Excavation shall apply to the removal of bedrock and ledgerock which cannot be accomplished without blasting or the use of rippers, and the use or disposal of such material. Excavation of material classified as "rock" shall conform to the requirements of Section 201 of the Standard Specifications.

C. Rock Excavation for Structures and Trenches shall apply to the removal, use, or disposal of all boulders or other detached stones having a volume of 1/2 cubic yard or more. Excavation of such material shall conform Section 201 of the Standard Specifications.

D. Undercut Excavation

1. If unsuitable bearing materials are encountered at the required subgrade elevations notify a Geotechnical Engineer immediately, and have the work reviewed by a Geotechnical Engineer.
2. Unstable bearing materials shall be removed to a depth of one foot below subgrade and replaced with one foot of graded aggregate base course.
3. Base course shall be placed and compacted in six-inch lifts.

E. Stability of Excavations

1. Slope sides of excavations to comply with local codes and ordinances having jurisdiction. Shore and brace where sloping is not possible because of space.
2. Maintain sides and slopes of excavations in a safe condition until completion of backfilling.

F. Shoring and Bracing

1. Provide materials for shoring and bracing, such as sheet piling, uprights, stringers and cross-braces, in good serviceable condition.
2. Establish requirements for trench shoring and bracing to comply with local codes and authorities having jurisdiction
3. Maintain shoring and bracing in excavations regardless of time period excavations will be open.
4. Brace, sheet, and support trench walls in such a manner that they will be safe and that the ground alongside the excavation will not slide or settle, and that all existing improvements of every kind, whether on public or private property, will be fully protected from damage.
5. In the event of damage to such improvements, immediately make all repairs and replacements necessary at no additional cost to the Owner.
6. Arrange bracing, sheeting and shoring so as to not place stress on any portion of the completed work until the general construction thereof has proceeded far enough to provide sufficient strength.
7. Exercise care in the drawing and removal of sheeting, shoring, bracing and timbering to prevent collapse and caving of excavation faces being supported.

G. Dewatering

1. Prevent surface water and subsurface or groundwater from flowing into excavations and from flooding the project site and surrounding area.
2. Do not allow water to accumulate in excavations. Remove water to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to the stability of subgrades and foundations. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water from excavations.
3. Convey water removed from excavations and rainwater to collecting or runoff areas, which are not subject to erosion. Establish and maintain temporary drainage ditches and other diversions outside excavation limits for each structure. Do not use trench excavations as temporary drainage ditches.

H. Material Storage

1. Stockpile satisfactory excavated materials where directed until required for use as backfill or fill. Place, grade and shape stockpiles for proper drainage.
2. Locate and retain soil materials away from edge of excavations.
3. Dispose of excess soil material and waste materials as herein specified. Excavated material unsuitable for backfilling shall be kept separate from other materials excavated, and disposed of. Materials suitable for backfilling shall not be disposed of until completion of filling or backfilling operations.

I. Excavation for Pavements and Pavement Patches

1. Cut surface under pavements to comply with cross- sections, elevations and grades as shown.

J. Excavation for Trenches

1. Dig trenches to the uniform width required for the particular item to be installed sufficiently wide to provide ample working room. Trench width to a point no less than two feet (2') above the outside top of pipe shall be the pipe outer diameter plus twenty-four inches (24").
2. Excavate trenches to the depth indicated or required. Carry the depth of trenches for piping to establish the indicated flow lines and invert elevations. Beyond the building perimeter, keep bottoms of trenches for which elevations are not given sufficiently below finish grade to avoid freeze-ups.
3. Trenches for pipes shall not be opened more than the number of linear feet of pipe that can be placed and backfilled in one (1) day.
4. Grub roots and stumps within six inches (6") of outside surface of pipe bottom and sides to minimum depth of six inches (6") below grade. Backfill trenches with concrete where trench excavations pass within eighteen inches (18") of column or wall footings and which are carried below the bottom of such footings, or which pass under wall footings. Place concrete to the level of the bottom of adjacent footing.
5. Pipe bedding shall be as shown on the Plans.

K. Cold Weather Protection

1. Protect excavation bottoms against freezing when atmospheric temperature is less than thirty-five degrees (35°).

L. Infiltrating Stormwater Management Facilities

1. To prevent compaction of stormwater management areas intended to provide infiltration, excavation below the minimum elevation for the sediment trap as noted on the Plans shall not be permitted during bulk grading operations.
2. No wheeled construction equipment or vehicles shall enter the sediment trap/stormwater management area as identified on the Plans during the bulk grading stage of construction.
3. Upon final grading of the infiltrating stormwater management area, no equipment of any kind shall come into contact with the infiltrating in-situ subsoils of the facility. A minimum of 8” of the subsoils shall be scarified during final grading.

3.4 BACKFILL FILL AND COMPACTION

A. General

1. The project Inspector or a Geotechnical Engineer shall be notified 24 hours in advance of any fill, backfill or compaction operations.
2. Place acceptable material in 8" lifts to required subgrade elevations.
3. Fills: Use suitable material (per Section 2.2 of this section) obtained from on-site excavation, except use borrow material when suitable on-site material is not available.
4. Backfilling: Use suitable material (per Section 2.2 of this section) obtained from on-site excavation, except use select backfill where indicated on Plans. Backfill to a height of two feet (2') above the top of pipe with earth free from stones, rock fragments, dirt clogs or frozen material greater than two inches (2") in largest dimension.

5. Do not provide additional off-site borrow material until all acceptable excavated materials on the site have been utilized in the work unless approved by the Owner.
6. Place the various types of materials in the areas as designated on the Plans.

B. Backfill excavation as promptly as work permits, but not until completion of the following:

1. Inspection, testing, approval and recording locations of underground utilities.
2. Removal of concrete formwork.
3. Removal of shoring and bracing, and backfilling of voids satisfactory materials. Cut off temporary sheet piling driven below bottom of structures and remove in manner to prevent settlement of the structure or utilities, or leave in place if required.
4. Removal of trash and debris.
5. Permanent or temporary horizontal bracing is in place on horizontally supported walls.

C. Backfilling Prior to Approvals

1. Should any of the work be so enclosed or covered up before it has been approved, uncover all such work at no additional cost to the Owner.
2. After the work has been completely tested, inspected and approved, make all repairs and replacements necessary to restore the work to the condition in which it was found at the time of uncovering, all at no additional cost to the Owner.

D. Ground Surface Preparation Prior to Filling

1. Remove all vegetation, debris, topsoil, unsatisfactory soil materials, obstructions and deleterious materials from existing ground surface to a depth of not less than four inches (4") and not more than six inches (6") prior to placement of fills. Plow, strip or break-up sloped surfaces steeper than one (1) vertical to four (4) horizontal to a depth of not less than six inches (6") so that fill material will bond with existing surface.
2. When existing ground surface has a density less than that specified under "Compaction," for the particular area classification, break up the ground surface, pulverize, moisture condition to the optimum moisture content, and compact to required depth and percentage of maximum density.

E. Placement and Compaction

1. Place backfill materials in layers not more than eight inches (8") in loose depth.
2. Control soil compaction during construction providing minimum percentage of density specified for each area classification listed below.
3. Pavement areas are defined, for the purpose of this Section, as extending a minimum of five feet (5') beyond the building and/or pavement.
4. Compact soil to not less than the following percentages of maximum dry density for soils which exhibit a well-defined moisture density relationship determined in accordance with ASTM D-1557; and not less than the following percentages of relative density determined in accordance with ASTM D-4253, for soils which will not exhibit a well-defined moisture-density relationship.

    a. Lawn or Unpaved Areas: Compact top six inches (6") of subgrade and each layer of backfill or fill material at 90 percent (90%) maximum dry density.
    b. Walkways: Compact top six inches (6") of subgrade and each layer of backfill or full material at 95 percent (95%) maximum dry density or 90 percent (90%) relative dry density.

c. Pavement Areas: Compact top twelve inches (12") of subgrade and each layer of backfill or fill material at 95 percent (95%) maximum dry density or 90 percent (90%) relative dry density.
d. Base Course Materials: Compact each layer of base course material to 95% percent (95%) of maximum dry density.
e. Trench Stabilization Materials: Compact each layer of material to 95 percent (95%) of maximum dry density.

5. Moisture control:

a. Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade, or layer of soil material, to prevent free water appearing on surface during or subsequent to compaction operations.
b. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.
c. Soil material that has been removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. Assist drying by discing, harrowing or pulverizing until moisture content is reduced to a satisfactory value.
d. Moisture condition fills materials to within 3 percent (3%) of the optimum moisture. Fill that is so wet that it is unstable under compaction equipment shall be dried and re-compacted to achieve a stable fill.

6. Puddling or jetting will not be permitted.
7. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice, or other unsuitable materials.
8. Place backfill and fill material evenly adjacent to structures, to be required elevations. Take care to prevent wedging action of backfill against structures by carrying the material uniformly around structure to approximately same elevation in each lift.
9. Compact backfill to height of two feet (2') above top of pipe using approved flat-faced mechanical tampers.

F. Compost Stormwater Blanket

1. A two inch layer of compost blanket shall be pneumatically applied per the installation recommendations of Filtrexx International to achieve finished grade. No equipment of any kind may enter the stormwater management facility basin prior to or following compost installation. See Section 329000 for seeding instructions.

3.5 GRADING

A. General

Uniformly grade areas within limits of grading under this section, including adjacent transition areas. Smooth finished surface within specified tolerances, compact with uniform levels or slopes between points where elevations are shown, or between such points and existing grades.

B. Grading Outside Building Lines

Grade areas adjacent to building lines to drain away from structures and to prevent ponding. Finish surfaces free from irregular surface changes, and as follows:

1. Lawn or unpaved areas: Finish area to receive topsoil to within not more than 0.10 feet above or below the required subgrade elevations.
2. Walks: Shape surface of areas under walks to line, grade and cross-section, with finish surface not more than 1/2 inch above or below the required subgrade elevation.
3. Pavement: Shape surface of areas under pavement line, grade and cross-section, with finish surface not more than 1/2 inch above or below the required subgrade elevation. All topsoil and other unsuitable material shall be removed and replaced with suitable backfill.

C. Compaction

1. After grading, compact subgrade surfaces to the depth and percentage of maximum density for each area classification.

D. Treating after Grading

1. After grading is completed, permit no further excavating, filling or grading.
2. Use all means necessary to prevent erosion of freshly graded areas during construction and until such time as permanent drainage and erosion control measures have been installed.

E. Subgrade Preparation

1. All subgrade preparation shall be performed in accordance with the applicable Sections of the Delaware Department of Transportation Standard Specifications except as may be modified by this Specification Section.
2. Subgrades for paving shall be firm and unyielding when proof-rolled in accordance with Section 202 of the Standard Specifications.

3.6 GRADED AGGREGATE BASE COURSE

A. General

1. Base Course consists of placing graded aggregate base course material in layers of specified thickness over subgrade surface to support pavements, pavement patches and structures, as shown on Plans.
2. Provide Base Course in accordance with Section 301 of the Standard Specifications, except as otherwise modified by this Specification Section.

B. Grade Control

1. During construction, maintain lines and grades including crown and cross-slope of base course.

C. Placing

1. Place base course material on prepared subgrade in layers of uniform thickness, conforming to indicated cross-section and thickness. Maintain optimum moisture content for compacting base course material during placement operations.
2. When a compacted base course is shown to be eight inches (8") or less, place material in a single layer. When shown to be more than eight inches (8") thick, place material in equal layers, except no single layer shall be more than eight inches (8") in thickness when compacted.
3. Spread, shape and compact all base course material deposited on the subgrade during the same day.

3.7 FIELD QUALITY CONTROL

A. Quality control testing during construction. Allow testing service to inspect and approve subgrades and fill layers before further construction work is performed.

B. If subgrade or fills which have been placed are below specified density, provide additional compaction and testing at no expense to the Owner. This shall include compaction and testing at areas initially tested and at other locations as directed.

3.8 MAINTENANCE

A. Protection of Graded Areas

1. Protect newly graded areas from traffic and erosion. Keep free of trash and debris.
2. Repair and establish grades in settled, eroded and rutted areas to specified tolerances.

B. Reconditioning Compacted Areas

1. Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, reshape and compact to required density prior to further construction.

3.9 DISPOSAL OF EXCESS AND WASTE MATERIALS

A. Remove waste materials, including excess and unacceptable excavated material, trash and debris, and dispose of it off the Owner's property.

3.10 TOPSOILING

A. Preparation

1. Verify that clearing, earthwork, grading and other preceding work affecting ground surface have been completed and that the area to be topsoiled is cleared, shaped, and dressed.
2. Preparation of Topsoil Subsoil
   a. Shape and dress area to be topsoiled. This work includes grading to required lines and elevations; removal of all stones, clods, lumps two inches or larger in any dimension; removal of all wires, cables, pieces of concrete, tree roots, and debris or other unsuitable material.
   b. Do not proceed with installation of topsoil until this work has been approved.

B. Installation

1. Place in even layers that will produce the minimum compacted thickness as indicated on the Plans.
2. If the quantity of topsoil obtained from stripping is insufficient for the project requirements, provide required topsoil from approved sources located outside project limits.
3. Within the Multipurpose field area shown on the Plans, remove stones, lumps, roots and other objects larger than one-half inch in any dimension from graded topsoil surface using a mechanical landscape rake.

C. Maintenance

1. Immediately before establishment of ground cover, re-topsoil and regrade areas, which become eroded or otherwise disturbed.
2. Perform all maintenance work in accordance with the Specifications without additional compensation.
3. Maintenance period to extend until installation of ground cover.

D. Cleaning

1. Immediately clean spills, soil, and conditioners on paved and finished areas.
2. Haul and dispose of topsoil in excess of the quantity required for the project off site.
3. Dispose of protective barricades and warning signs at termination of maintenance period.

END OF SECTION

SECTION 312500
EROSION AND SEDIMENT CONTROLS

PART 1 - GENERAL

1.1 DESCRIPTION

A. General: Provide temporary soil and sediment control measures in accordance with the Plans and Contract Documents.

1.2 QUALITY ASSURANCE

A. Standards
Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations of the following:

1. Delaware Erosion and Sediment Control Handbook, current edition.
2. Delaware Department of Transportation Standard Specifications for Highways and Bridges, dated August 2016 (hereinafter referred to as the “Standard Specifications”).

B. Design Criteria

1. The primary objective of this specification is to control soil erosion to the maximum extent practicable.
2. The temporary control provisions contained herein shall be coordinated with permanent erosion control features to the extent practical to assure effective and continuous erosion control throughout the construction and post- construction period.
3. The erosion control measures described herein shall be continued until the construction is complete and all disturbed areas are fully stabilized.
4. Wherever construction exposes work which is subject to erosion, erosion control features or other work to be completed within such areas shall follow as soon after exposure as practicable.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Temporary mulches shall conform to Section 908 of the Delaware Department of Transportation Standard Specifications for Bridges and Highways.

B. Temporary grass mixtures shall be as shown on the Plans, or in the absence of plan information, shall conform to the Section 908 of the Standard Specifications.

C. Temporary structural Erosion Control measures shall conform to the requirements of the Delaware Erosion and Sediment Control Handbook and the Delaware Department of Transportation Standard Specifications.

D. Erosion control matting and blankets shall conform with the Delaware Erosion and Sediment Control Handbook requirements for soil stabilization matting (SSM) I and II. Matting shall be composed of 100% agricultural straw (minimum 0.5 pounds per square yard) or 100% wood excelsior fiber (0.8 pounds per square yard) with a single or double netting of bio-degradable

material. SSM-I shall be North American Green S75BN, Carthage Mills ECS-1B, American Excelsior Curlex I, or approved equal. SSM-II shall be North American Green S150BN, Carthage Mills ECS-2B, American Excelsior Curlex II, or approved equal.

PART 3 - EXECUTION

3.1 CONSTRUCTION REQUIREMENTS

A. Vegetative stabilization shall be used on graded or cleared areas, which are subject to erosion for a period of 14 days or more.

B. All temporary erosion control measures shall be installed in accordance with the Delaware Erosion and Sediment Control Handbook.

C. Erosion control matting shall be installed in accordance with the manufacturer's written instructions, the requirements of the Delaware Erosion and Sediment Control Handbook, and the details on the Plans.

D. In the event of conflict between these requirements and pollution control laws, rules, or regulations of other federal or state agencies, the more restrictive laws, rules, or regulations shall apply.

E. The Contractor shall be responsible for maintaining all soil erosion and sediment control measures in an acceptable and functional manner. The Contractor shall remove all temporary measures after all other construction is complete, final restorations installed, and all disturbed areas have been adequately stabilized.

END OF SECTION

SECTION 320523

CEMENT AND CONCRETE FOR EXTERIOR IMPROVEMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Remove existing concrete sidewalk as shown on the plan, marked in the field, or as directed by the Engineer.

B. Provide new concrete sidewalk, paving and stairs with reinforcing as designated on the Plans, marked in the field, or as directed by the Engineer.

C. Place Graded Aggregate Base Course below proposed concrete sidewalks.

D. Construct accessible curb ramps with detectable warning surfaces.

E. Stamp and integrally color concrete as indicated on the Plans, marked in the field, or as directed by the landscape architect.

1.2 STANDARDS

A. The quality of materials and performance of work specified in this section shall be in accordance with the Delaware Department of Transportation Standard Specifications for Road and Bridge Construction, dated August 2016 (hereinafter referred to as the "Standard Specifications").

Section 301: Graded Aggregate Base Course
Section 504: Crack and Joint Sealing
Section 611: Concrete Reinforcement
Section 705: P.C.C. Sidewalk, Curb Ramps, and Sidewalk Detectable Warning System
Section 762: Saw Cutting and Butt Joints
Section 1022: Portland Cement Concrete Production
Section 1037: Concrete Reinforcing
Section 1042: Joint / Crack Sealant Material

1.3 SUBMITTALS

A. Certificates: All deliveries of concrete shall be accompanied by delivery slips.

B. For Integrally Colored Concrete

1. Submit product data for color additives and curing products. Submit the manufacturer’s color chart for the Landscape Architect to select the concrete colors.

C. For Stamped Concrete

1. Manufacturer’s standard specifications, including product characteristics and criteria.
2. Manufacturer’s instructions and recommendations on delivery, storage, handling, preparations and application.
3. Shop drawings showing stamp layout and pattern.
4. Following approval of the above documents, submit a sample showing pattern, texture and color as selected by the Landscape Architect.
   a) Sample shall be a minimum of 24 inch x 24 inch.

b) Sample shall be submitted on minimum 1/2 inch thick plywood.
c) Concrete shall be a minimum of 1/2 inch thick or thicker as needed to adequately show pattern and texture.
d) Certification that the material complies with the manufacturer's performance characteristics and criteria.

5. Following approval of the sample, submit a manufacturer's field inspection report within 5 days of a manufacturer's site inspection.

D. Manufacturer's standard specifications, including product characteristics and criteria shall be submitted for galvanized steel handrails and cast aluminum stair nosing.

1.4 ENVIRONMENTAL REQUIREMENTS

A. Allowable Concrete Temperatures

1. Cold weather: 60 degrees Fahrenheit. (18° C) when discharged from the mixer.
2. Hot weather: Maximum concrete temperature is 80 degrees Fahrenheit. (30° C).

B. Do not place concrete during rain, when atmospheric temperature is at or below 36 degrees Fahrenheit (2° C), or when conditions are otherwise unfavorable.

1.5 PROTECTION

A. Protect concrete from pedestrian and vehicular traffic until concrete has been sufficiently cured.

PART 2 - PRODUCTS

2.1 CONCRETE MATERIALS

A. Concrete

1. Use concrete developing a compressive strength of 4,000 p.s.i., or as specified on the Plans, at twenty-eight (28) days.
2. Use air-entrained concrete.

B. Cement, aggregates, water and air-entrainment methods and materials conforming to Section 1022 OF the Standard Specifications for Class B concrete.

C. Joint filler: Pre-formed expansion joint material, conforming to Section 1042 of the Standard Specifications.

D. Curing compound: White pigmented liquid, conforming to AASHTO M 148 for Type 2, Class A or B.

E. Vapor barrier: Where called for on Plans shall be 6 mil. polyethylene.

F. Welded Wire Fabric as specified on the Plans shall conform to AASHTO M 55.

G. Billet-steel bar reinforcement as specified on the Plans shall conform to AASHTO M 31, Grade 60 or ASTM A 706, Grade 60.

H. Galvanized steel handrail piping shall as specified on the Plans shall conform to ASTM A53. Aluminum handrail piping shall as specified on the Plans shall conform to ASTM B 429.

I. Cast aluminum stair nosing as specified on the Plan shall conform to Federal Specification No. RR-T-650 Type C, Class 4, ASTM A-48-56.

2.2 GRADED AGGREGATE BASE COURSE

A. Graded aggregate base course shall meet the requirements of Section 1005 of the Standard Specifications for Type B graded aggregate base course.

2.3 ACCESSIBLE CURB RAMPS

A. Detectable warning systems shall meet the requirements of Section 705.03.7.E and 705.03.7.F of the Standard Specifications.

B. Dome sizes and patterns shall be as shown on the Plan.

2.5 COLOR ADDITIVES

A. Color additives shall be concentrated pigments specially processed for mixing into concrete. Pigments shall comply with ASTM C979, and shall be color sable, nonfading, and resistant to lime and other alkalis.

B. Color additives shall be of one manufacturer, and shall be as produced by Davis Colors, Solomon Colors, or approved equal. Colors to be selected by Landscape Architect from manufacturer's available colors.

2.5 CONCRETE STAMPING

A. Pattern shall be as selected by the Landscape Architect and as shown on approved sample.

B. Concrete stamping form release agent shall be a metal oxide, colored as selected by the Landscape Architect.

C. Concrete sealer shall be an acrylic penetrating sealer or as specified by manufacturer.

PART 3 - EXECUTION

3.1 PREPARATION FOR NEW CONCRETE

A. Excavate subgrade and set forms so that finished surface conforms to lines and grades shown on Plans.

B. Prepare concrete as specified in Section 705 of the Standard Specifications.

C. Verify that earthwork is completed to correct line and grade.

D. Verify that forms conform to line, grade and dimensions shown on Plans.

E. Check that subgrade is smooth, compacted and free of excessive moisture.

F. Do not commence work until conditions are satisfactory.

3.2 CONSTRUCTION METHODS

A. Concrete shall be constructed in accordance with the requirements of Section 705 of the Standard Specifications.

B. The foundation shall be formed at the required grade to accommodate the elevations, dimension, and details shown on the Plans for the bottom of the sidewalk. All soft and yielding or otherwise unsuitable materials shall be removed and replaced with Delaware #57 aggregate.

C. Furnish and place concrete reinforcement and galvanized steel hand railings in accordance with the Plans, Section 611 of the Standard Specifications and the manufacturer's recommendations.

D. Furnish and place cast aluminum stair nosing in accordance with manufacturer's recommendations. Stair nosing is designed to be fully embedded in substrate to provide full support on underside of nosing. Installer shall tamp down the stair nosing before the initial set of the concrete to fully seat it into the substrate and ensure proper concrete formation around the anchors on the underside.

E. Construct accessible curb ramps in accordance with the details shown on Plans and the requirements of Section 705.3.7 of the Standard Specifications.

F. Concrete shall be cured for a minimum of five days. The sidewalk shall not be opened to pedestrian and vehicular traffic until the end of the curing period.

G. Expansion joints shall extend from the surface to the foundation and shall be at right angles to the concrete surface. An expansion joint shall be placed across concrete as denoted on the Plans, or at approximately 20 foot intervals on sidewalks. Expansion material shall also be placed next to curbs, pavements, and fixed civil structures, and around all appurtenances, such as manholes, utility boxes, and poles that extend into and through the sidewalk.

3.3 INTEGRALLY COLORED CONCRETE

A. Mix in colored additive in accordance with manufacturer's written instructions. Mix until the color additives are uniformly dispersed throughout the mixture and disintegrating bags, if used, have fully disintegrated.

H. Clean finished surface to remove any efflorescence. Do not use muriatic or hydrochloric acid on integrally colored concrete.

3.4 CONCRETE STAMPING

A. Ensure cast-in-place concrete is wood floated to uniform surface.
B. Work release agent into concrete slab (Color as selected by the Landscape Architect).
C. Perform stamped concrete finishing by imprinting concrete with stamp pattern and texture as selected by the Landscape Architect.
D. Seal finished work in accordance with sealant manufacturer's recommendations.

END OF SECTION

SECTION 321216
ASPHALT PAVING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work included: Provide labor, materials, and equipment necessary to complete the work of this Section, including but not limited asphalt paving parking areas, entrances and entrance roads per the following:

1. Saw cutting and Milling existing pavements.
2. Patching pavement, including removal of existing pavement and installation of bituminous concrete base course patch.
3. Surface preparation, and installation of Type B, binder course pavement.
4. Installation of Type C, wearing surface course for pavement patching, and for overlay of existing bituminous pavement including patched and repaired areas.
5. Pavement markings.
6. Traffic control and signage.

1.2 STANDARDS

A. The quality of materials and performance of work specified in this section shall be in accordance with the Delaware Department of Transportation Standard Specifications for Road and Bridge Construction, dated August 2016, latest revision (hereinafter referred to as the "Standard Specifications").

1. Section 401: Bituminous Pavement
2. Section 402: Bituminous Paving Materials, Patching
3. Section 760: Pavement Milling
4. Section 762: Saw Cutting and Butt Joints
5. Section 817: Pavement Marking
6. Section 1011: Tack Coat
7. Section 1014: Asphalt Materials Production

B. All pavement markings shall be in accordance with the Delaware Manual on Uniform Traffic Control Devices, dated 2011, latest revision, and the Delaware Department of Transportation Striping Item Usage Guidelines (Permanent Pavement Markings – Conventional Roads), dated 1/4/2017, latest revision.

1.3 DEFINITIONS

A. Subgrade: Surface upon which pavements will be constructed.

B. Base Course: That portion of the pavement cross section consisting of graded aggregate base course or bituminous concrete deep lift.

1.4 QUALITY ASSURANCE

A. Bituminous concrete producer shall be regularly engaged in the production of hot-mix, hot-laid bituminous concrete, and shall be approved by the Delaware Department of Transportation or the Pennsylvania Department of Transportation.

1.5 SUBMITTALS

A. Job mix formula.

B. Provide copies of delivery slips at the end of each working day.

PART 2 - PRODUCTS

2.1 GENERAL

A. Materials and mixtures shall comply with the following sections of Delaware Department of Transportation Standard Specifications. All bituminous concrete paving shall be obtained from a DelDOT approved plant.

2.2 PAVING MATERIALS AND MIXTURES

A. Graded Aggregate Base Course

1. Materials: Sections 301 and 1005.

B. Hot Mix, Hot Laid Bituminous Concrete Pavement

1. Materials: Section 401.
2. Mixture: Section 401

C. Emulsified Asphalt: Section 1016

D. Course and Fine Aggregate: Sections 1003 and 1004

E. Tack Coat: Meeting the requirements of Section 1011 of the Standard Specifications

2.3 JOB MIX FORMULA REQUIREMENTS

A. Provide job mix formulas for each required bituminous concrete mixture as specified in Section 401 of the Standard Specifications.

B. Submit for approval prior to beginning paving operations.

2.4 MIX DESIGN AND CONTROL REQUIREMENTS

A. The design and control requirements for all paving mixtures shall conform to Section 401 of the Standard Specifications.

2.5 SAMPLES AND TESTING

A. Methods and rates of sampling bituminous mixtures shall conform to Section 1014 of the Standard Specifications with the following exceptions:

1. Sampling shall be performed by the producer's quality control technician.
2. For small scale projects where it is possible to attain the minimum lot size specified, a total of five (5) samples shall be taken at random for each type of mix specified, per each day's production.

B. Testing of bituminous concrete mixtures to determine the quantity of bitumen, gradation of aggregate, and conformance to mix design requirements shall be as specified in Section 1014 of the Standard Specification.

C. Submit results of tests on forms signed by producer's quality control technician.

2.6 PREPARATION OF MIXTURES

A. The preparation of all bituminous mixtures shall conform to Section 1014 of the Standard Specifications.

2.7 PAVEMENT MARKINGS

A. All paint shall be of materials approved by the Delaware Department of Transportation per Sections 817 and 1071 of the Standard Specifications for Latex or Epoxy Paint. Glass beads will not be required for paint striping in parking lots or private driveways.

B. Thermoplastic material, where shown on the plan or required by DelDOT, shall meet the requirements of Section 817 and 1071 of the Standard Specifications.

2.8 TRAFFIC CONTROL SIGNS

A. All traffic control signs and posts shall conform with the Delaware Manual of Uniform Traffic Control Devices, the Standard Specifications, and the Americans with Disabilities Act.

B. Street signs shall conform with the requirements of the Town of Whitehall and DelDOT requirements, and shall be of a consistent style with street signs in the surrounding neighborhood.

PART 3 - EXECUTION

3.1 GENERAL

A. The method of construction including bituminous concrete plant and equipment, bituminous concrete pavers, vehicles for transporting bituminous mixtures, rollers, and all construction methods shall conform to Section 401 of the Standard Specifications except as modified by the Supplemental Requirements below.

3.2 SAW CUTTING AND PAVEMENT MILLING

A. Construction methods for saw cutting and pavement milling shall conform to Sections 760 and 762 of the Standard Specifications.

3.3 PAVEMENT PATCHING

A. Construction methods for patching pavement shall conform to Sections 401 and 402 of the Standard Specifications. A milling machine may be use for pavement and base course removal.

3.4 PROOF ROLL

A. Proof roll subgrade surfaces using heavy, rubber-tired rollers, or loaded dump truck in accordance with Section 202 of the Standard Specifications. Proof roll in the presence of the Owner's Representative.
   1. Subgrades shall be firm and unyielding.
   2. Compact areas showing deflection and instability.

B. Notify the Engineer or the Inspector of unsatisfactory conditions.

C. Do not begin paving work until any such unsatisfactory conditions have been corrected.

3.5 SURFACE PREPARATION

A. Earth and Base Course Surface
   1. Remove loose and foreign material from compacted subgrade surface immediately before application as required.
   2. Use power broom or blowers and hand brooming as required.
   3. Do not displace subgrade material.

B. Existing Pavement Surfaces

   1. Remove loose and foreign material from existing pavement surfaces immediately before application of paving
   2. Use self-propelled mechanical sweepers. Supplement with hand brooming as required.
   3. Pay particular attention to cleaning of gutter lines and outer edges of pavement areas.
   4. Remove all weeds, grass or other vegetative matter growing in pavement areas, particularly along joints and curbs.

C. Minor Patching

   1. Existing pavement surfaces: Fill in depressions, and patch pavement in overlay areas that are not marked out for base repairs.

3.6 TACK COAT

A. Apply to cleaned surfaces of all pavements to be overlaid or slurry seal coated.

B. Apply to cleaned surfaces of newly constructed base pavement if coated with dust, dirt, foreign materials in sufficient amount to prevent bond with surface course.

C. Apply to edges of paving where base repairs are to be made.

D. Apply tack coat material at temperatures, specified in Section 401 of the Standard Specifications.

E. Apply at a uniform rate of 0.05 to 0.15 gallons per square yard immediately prior to placing pavement.

F. Apply tack coat by brush to contact surfaces of pavement cold joints, curbs, gutters, manholes, and other structures projecting into or abutting asphalt concrete pavement.

G. Allow surfaces to dry until material is in a condition of tackiness to receive pavement.

H. Take precautions to insure tack coat is not applied to exposed surfaces of curbs or other exposed surfaces. Tack coat so applied shall be removed by Contractor at no additional cost to Owner.

3.7 GENERAL SURFACE REQUIREMENTS

A. Test finished surface of each bituminous concrete course for smoothness using a ten (10) foot straightedge.

B. The straightedge shall have projections on the bottom at each end, either built-in or firmly attached, so that it is supported six (6") inches above the pavement surface at the ends. It shall be free from warp and deflection, and furnished by the Contractor without additional compensation.

C. Check surfaced areas at intervals and in directions specified.

D. Check surfaces for pavement smoothness immediately after initial compaction, and correct variations by removing or adding material as may be necessary. Then rolling shall be continued as specified.

E. Immediately after final rolling and while the pavement is still hot, the smoothness of the course shall be checked again and all projections or depressions exceeding the specified tolerances shall be corrected by removing defective work and replacing it with new surface course as specified. Portions of the surface otherwise unsatisfactory shall be replaced.

F. Finished surfaces shall be free of all roller marks, ridges and voids.

3.8 FIELD QUALITY CONTROL

A. Taking of pavement cores and testing for the determination of conformance to control air voids and pavement thickness, when required, shall be performed in accordance with Section 401 of the Standard Specifications.

B. When required per the General or Special Provisions, the Contractor shall employ and pay for the services of an Independent Testing Laboratory acceptable to the Engineer to perform additional field quality control sampling and testing when initial tests indicate work does not comply with the Contract Documents. All sampling and testing shall be performed as specified in section 401 of the Standard Specifications.

C. Areas of pavement removed for field quality control testing shall be replaced by the Contractor as follows:

1. Clean debris from core area. Cut all exposed pavement edges vertical.
2. Apply tack coat to exposed surfaces before installing replacement pavement.
3. Fill core area with surface course mixture for the full depth of the core.
4. Compact and grade mixture; seal repaired area with tack coat; and apply thin layer of sand over tack coat.

3.9 PAVEMENT MARKINGS

A. Paint equipment and installation shall conform to Section 817 of the Standard Specifications.

B. Application of Thermoplastic materials, where required, shall conform to Sections 817.03.5 of the Standard Specifications.

C. All markings shall comply with the Manual on Uniform Traffic Control Devices, the Delaware Manual on Traffic Controls for Street and Highway Construction and Maintenance, the Delaware State Fire Prevention Regulations, and the Delaware State Accessibility Board.

3.10 TRAFFIC CONTROL SIGNS

A. Traffic control signs shall be installed in accordance with the Delaware Manual of Uniform Traffic Control Devices, and the Standard Specifications.

END OF SECTION

SECTION 321613
CONCRETE CURB

PART 1 - GENERAL

1.1 DESCRIPTION

A. Remove and dispose off site existing concrete or bituminous curb as shown on the Plans, marked in the field, or as directed by the Engineer.

B. Install new poured Portland cement concrete curb in the locations designated on the Plans, marked in the field, or as directed by the Engineer.

1.2 STANDARDS

A. The quality of materials and performance of work specified in this section shall be in accordance with the Delaware Department of Transportation Standard Specifications for Road and Bridge Construction, dated August 2016 (hereinafter referred to as the "Standard Specifications").

Section 701: Portland Cement Concrete Curb, Integral Portland Cement Concrete Curb, Portland Cement Monolithic Median, and Curb Openings
Section 1022: Portland Cement Concrete Production

1.3 SUBMITTALS

A. Certificates: All deliveries of concrete shall be accompanied by delivery slips.

1.4 ENVIRONMENTAL REQUIREMENTS

A. Allowable Concrete Temperatures

1. Cold weather: 60 degrees Fahrenheit. (18° C) when discharged from the mixer.
2. Hot weather: Maximum concrete temperature is 80 degrees Fahrenheit. (30° C).

B. Do not place concrete during rain, when atmospheric temperature is at or below 36 degrees Fahrenheit (2° C), or when conditions are otherwise unfavorable.

1.5 PROTECTION

A. Protect new concrete curb from traffic for a minimum of seven (7) days.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Concrete

1. Use concrete developing a minimum compressive strength of 4,000 p.s.i., or as specified on the Plans, at twenty-eight (28) days.
2. Use air-entrained concrete.

B. Cement, aggregates, water and air-entrainment methods and materials conforming to Section 1022 of the Standard Specifications for Class B concrete.

C. Joint filler: Pre-formed expansion joint material, conforming to Section 1042 of the Standard Specifications.

D. Curing compound: White pigmented liquid, conforming to AASHTO M 148 for Type 2, Class A or B.

E. Bituminous Joint Sealant: Conforming to the requirements of section 1042 of the Standard Specifications:

PART 3 - EXECUTION

3.1 PREPARATION

A. When encountered, cut existing pavements vertically with a sharp tool on a straight line prior to excavating for curb. Cut shall be made twelve inches (12”) to twenty-four inches (24”) beyond the limits of excavation, and maintained straight and neat, or re-cut and dressed as required.

B. Excavate subgrade and set forms so that finished curb conforms to required lines and grades.

C. Prepare curb subgrade as specified in Section 701 of the Standard Specifications.

D. Verify that earthwork is completed to correct line and grade.

E. Verify that forms conform to proposed line, grade and curb cross section.

F. Check that subgrade is smooth, compacted and free of frost and excessive moisture.

G. Do not commence work until conditions are satisfactory.

3.2 PERFORMANCE

A. Method of curb construction shall conform with Section 701 of the Standard Specifications

1. Install 1/2-inch wide expansion joints at equal intervals, not to exceed forty feet (40'). Install additional expansion joints where curb abuts structures, and install expansion joints or bond breaker where curb abuts sidewalk. Fill expansion joints with joint filler, 1/2-inch thick. Insert joint filler 1/4-inch from the top and face of curb.
2. Construct contraction joints (transverse joints) at 10' intervals, except where shorter sections are necessary for closures; but no section shall be less than four feet (4').
3. Finish concrete surfaces of curb to match existing adjacent curbs. Curb cross section shall be as shown on the Plans.

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END OF SECTION

SECTION 321816.13

PLAYGROUND PROTECTIVE SURFACING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This work includes finishing and installing the specified safety surface.

1.2 DESCRIPTION OF SYSTEM

A. Safety Turf shall be poured-in-place to provide a resilient, rubber surface installed over a base as specified. The surfacing contractor shall be responsible for all labor, materials, tools, and equipment to perform all work and services for the installation of the surface.

1.3 QUALITY ASSURANCE

A. Impact attenuation test results will be provided to the owner's representative. This will also include HIC test results. Test results shall meet or exceed ASTM-F1292-04 Impact Attenuation Guidelines of 200 G's or less from the actual fall height. HIC test results shall be less than 1000 at this fall height. Surface shall be accessible per ASTM- F1951-99 Determination of Accessibility of Surface Systems under and Around Playground Equipment. Surfacing should be installed per ASTM and CPSC guidelines.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURER

Safety Turf, Inc., Robertson Industries, Inc., BYO Recreation, or an approved equivalent manufacturer.

2.2 MATERIALS

A. POURED BASE LAYER - A precise combination of recycled SBR and Butyl rubber mixed on site with a MDI polyurethane prepolymer binder. Recbase® or an approved equivalent may be used in conjunction with base rubber for thicknesses over 3".

B. POURED 1/2" TOP LAYER – EPDM or TPV rubber granules (1-4mm size) and a solvent free, enhanced UV stable, MDI polyurethane prepolymer binder. (Note: An aliphatic binder may be used if initial "yellowing" of light colored granules is undesirable)

C. COLOR- Colors will be chosen by owner or owner's representative

PART 3 - PROCEDURE

3.1 SUB BASE

A. If the surface is existing (or new) asphalt or concrete, a not larger than a 1" deep by 1" wide keyway is to be cut into surface along the perimeter of the safety surface area. This will provide for a stopping point for the beveled perimeter edge allowing for a barrier free accessibility.

B. If asphalt or concrete is not used, then the sub base will be a compacted stone base. This base shall be prepared with a minimum of 4" of DE #57 stone that is spread and compacted to a flat

surface leaving the thickness of the required safety surface below finish level. Please note that a greater thickness of stone may be required if the existing material being removed is, for example wood chips.

3.2 INSTALLATION

A. THICKNESS - Total minimum depth of the safety surface will be 2”. The thickness may be adjusted to meet the fall height requirements noted in section 1.1.2.

B. POURED BASE LAYER - The 1 ½” min. layer of recycled SBR/Butyl will be mixed on site with a MDI polyurethane prepolymer binder in a mortar mixer. Mix until they are coated uniformly. This layer will be poured in place by means of a screed and hand trowel. Edge conditions shall be per project requirements. The minimum temperature requirement for installation of the base layer is 40 degrees and rising. Cure time increases at lower temperatures and humidity. (Note: This layer will be adjusted to the correct thickness per fall height requirements. Recbase® or an approved equivalent, may be used in conjunction with rubber base layer for thicknesses 3” or better.)

C. POURED TOP LAYER - The 1/2” poured top layer shall be composed of EPDM or TPV granular rubber. The EPDM or TPV rubber is mixed on site with a MDI polyurethane prepolymer binder in a mortar mixer. Mix granules until they are coated uniformly. The top layer will be poured-in-place and hand trowel or rolled. If the safety matting is installed over existing asphalt or concrete, the EPDM or TPV granules will be troweled into the keyway to provide a smooth transition from the existing surface onto the safety matting. The minimum temperature requirement for installation of the top layer is 50 degrees and rising. Cure time increases at lower temperatures and humidity. Day seams may be required for areas greater than 3,000 square feet. Edges - Surface edges shall be flush with the edge of adjacent area, or be such that there is a smooth transition onto the safety matting from the existing surface, or per owner’s requirements.

D. POROSITY - Surface shall be porous to the extent of allowing the equivalent of 12” per hour of rainfall to flow through it.

E. TRACTION - Surface shall be non-skid, wet or dry.

F. SOFTNESS - Surface deflection with a 30 lb. Load shall be ¼” to ½” with 99% recovery.

G. HEALTH & ENVIRONMENT AFTER CURING - Surface shall be non-toxic, non-allergenic and non-polluting.

3.3 PROTECTION

The safety surface should be protected from foot traffic for a minimum of 24 hours after installation to allow surface to cure. Note: This curing time may be longer in colder weather.

END OF SECTION

SECTION 323114

TUBULAR BARRIER GATE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Tubular swing gate.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, maintenance and operation manuals, material descriptions, dimensions of individual components, operating characteristics, fittings, accessories and finishes for the following:

a. Gates and hardware.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain gate as complete unit, including hinges, fittings, and accessories from single source from single manufacturer.

B. ACCEPTABLE MANUFACTURERS

Pioneer Fence Co. Inc., Hoover Fence Co., or an approved equivalent manufacturer.

2.2 SWING GATES

A. General: ASTM F 900 for gate posts and single swing gate types.

1. Gate Leaf Width: As indicated.
2. Framework Member Sizes and Strength: Based on gate height of 4 feet.

B. Pipe and Tubing:

1. Zinc-Coated Steel: ASTM F 1043 and ASTM F 1083.
2. Gate Posts: Round tubular steel or rectangular tubular steel.
3. Gate Frames and Bracing: Round tubular steel or rectangular tubular steel.

C. Frame Corner Construction: Welded.

D. Hardware:

1. Hinges: 180-degree inward swing.
2. Latch with provision for padlocking.

2.3 FITTINGS

A. Provide fittings according to ASTM F 626.

B. Post Caps: Provide for each post.

C. Finish: Metallic Coating for Pressed Steel: Not less than 1.2 oz./sq. ft. of zinc.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for earthwork, pavement work, and other conditions affecting performance of the Work.

1. Install gate posts prior to paving, unless otherwise permitted by Construction Manager. Gate shall not be installed until after paving operations.

3.2 PREPARATION

A. Stake or mark locations of gate and posts.

3.3 GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation.

3.4 ADJUSTING

A. Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding. Lubricate hardware and other moving parts.

END OF SECTION 323114

SECTION 323119

DECORATIVE METAL FENCE AND GATES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Furnish and install Ornamental Steel Fence, including foundations and appurtenances as shown on the Plans and described herein.

B. Furnish and install steel swing gates, including foundations and appurtenances as shown on the Plans and described herein.

C. Furnish and install slide gate with automated gate opener, including foundations, electrical connections, and appurtenances as shown on the Plans and described herein.

1.2 STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM A787 – Electric Resistance Welded Metallic Coated Carbon Steel Mechanical Tubing.
2. ASTM A653 – Steel Sheet Zinc Coated (Galvanized) by the Hot Dip Process
3. ASTM B117 – Practice for Operating Salt-Spray (Fog) Apparatus
4. ASTM D822 – Practice for Conducting Tests on Paint and Related Coating and Materials Using Filtered Open-Flame Carbon-Arc Light and Water Exposure Apparatus
5. ASTM D1654 – Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments.
6. ASTM D2794 – Test Method for Resistance to Organic Coatings to the Effects of Rapid Deformations (Impact)
7. ASTM D3359 – Test Method for Measuring Adhesion by Tape Test

1.3 SUBMITTALS

A. Submit shop drawings and product literature in accordance with the conditions of the Contract.

B. Submit operation and maintenance manuals for cantilevered gate.

C. Submit color selections for powder coated finishes.

1.4 QUALITY ASSURANCE

A. The Contractor shall provide laborers and supervisors who are experienced and thoroughly familiar with the construction involved and the materials and techniques specified. Upon request, the Contractor shall demonstrate the successful installation five similar fences and gates within the last three years.

B. The manufacturer or fabricator shall warrant the ornamental steel fence for ten (10) years against defects in workmanship or materials. The powder-coated surface shall be warranted for twenty (20) years against cracking, peeling, chipping, blistering, and corroding under normal usage. Cantilever slide gate shall be warranted from defects in workmanship or material for a period of fifteen (15) years from the date of purchase.

C. Fence and gates must be products of the same manufacturer.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Steel material for fence panels, posts, and swing gates shall conform to the requirements of ASTM A787, with a minimum yield strength of 45,000 psi.

B. The steel shall be hot-dip galvanized to meet the requirements of ASTM A653/A653M with a minimum zinc coating weight of 0.90 ounces per square foot.

C. Ornamental Steel Fence and Gates shall be as manufactured by Ameristar Perimeter Security, Iron World, Master Halco, or approved equal.

2.2 FABRICATION

A. Pickets, rails, and posts shall be pre-cut to specified lengths. Rails shall be pre-punched to accept pickets. Pickets shall be predrilled to accept retaining rods.

B. Pickets shall be installed into the pre-punched holes in the rails and shall be aligned to standard spacing using a specifically calibrated alignment. The aligned pickets and rails shall be joined at each intersection through fusion welding.

C. The manufactured panels, caps, rails, and posts shall be coated in a multi-stage process consisting of a pretreatment wash and a complete thermal stratification (multi-stage, high-temperature, multi-layer) electrostatic powder application system of both zinc rich epoxy and polyester. The color shall be black. The coated panels and posts shall be capable of meeting the performance requirements of ASTM D3359 for adhesion, ASTM B117 and B1654 for corrosion, ASTM D2794 for impact resistance, and ASTM D822 for weathering resistance.

2.3 SWING GATES

A. Swing gates shall be fabricated using welded ornamental panel material and gate ends of the size as shown on the Plans. All rail and upright intersections shall be joined by welding, as shall all picket and rail intersections.

B. Hardware shall be galvanized steel. Hinges shall grip post and frame firmly to prevent slippage. Hinges shall have a minimum load capacity of 1,000 pounds. Hinges shall allow gate leaf to swing 180-degrees.

PART 3 - EXECUTION

3.1 PREPARATION

A. Upon receipt at the job site, all materials shall be checked to ensure that no damage occurred during shipping or handling. Materials shall be stored in such a manner to ensure proper ventilation and drainage, and to protect it from damage and weather. Damaged or weathered fence and materials shall not be installed.

B. All new installations shall be laid out by the contractor in accordance with the Plans.

3.2 INSTALLATION

A. Fence posts shall be spaced as shown on the Plans or as recommended by the manufacturer. Fence posts shall be set in concrete footers having a minimum depth of 36 inches, or as shown on the Plans. Fence panels shall be attached to posts with brackets supplied by the manufacturer.

B. Fence shall be installed in accordance with the manufacturer's written instructions. Exposed steel surfaces shall be sealed with primer and paint furnished by the manufacturer.

C. Gates shall be installed in accordance with the manufacturer's written instructions.

END OF SECTION 323119

SECTION 323157

CAST-IN-PLACE CONCRETE FOR SCREEN WALL FOOTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes cast-in-place concrete for screen wall footing, including reinforcement, concrete materials, mixture design, and placement procedures.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.

B. W/C Ratio: The ratio by weight of water to cementitious materials.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

C. Steel Reinforcement Shop Drawings: Placing Drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.

1.5 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.
3. Steel reinforcement and accessories.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

B. Testing Agency Qualifications: An independent agency, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I. Testing agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician, Grade II.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

1.8 FIELD CONDITIONS

A. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When average high and low temperature is expected to fall below 40 deg F (4.4 deg C) for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301 (ACI 301M).
2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

B. Hot-Weather Placement: Comply with ACI 301 (ACI 301M) and ACI 305.1 (ACI 305.1M), and as follows:

1. Maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301 (ACI 301M).
2. ACI 117 (ACI 117M).

2.2 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.

2.3 REINFORCEMENT ACCESSORIES

A. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

2.4 CONCRETE MATERIALS

A. Cementitious Materials:

1. Portland Cement: ASTM C 150/C 150M, Type I/II.

B. Normal-Weight Aggregates: ASTM C 33/C 33M, coarse aggregate or better, graded. Provide aggregates from a single source.

1. Maximum Coarse-Aggregate Size: 3/4 inch (19 mm) nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Air-Entraining Admixture: ASTM C 260/C 260M.

D. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

E. Water: ASTM C 94/C 94M.

2.5 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.

2.6 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301 (ACI 301M).

2.7 CONCRETE MIXTURES FOR BUILDING ELEMENTS

A. Footings: Normal-weight concrete.

1. Minimum Compressive Strength: 3000 psi (20.7 MPa) at 28 days.
2. Maximum W/C Ratio: 0.50.
3. Slump Limit: 5 inches (125 mm) for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch (25 mm).
4. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 3/4-inch (19-mm) nominal maximum aggregate size.

2.8 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.9 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 EMBEDDED ITEM INSTALLATION

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

3.2 STEEL REINFORCEMENT INSTALLATION

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

3.3 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections are completed.

B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect.

C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301 (ACI 301M).

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
1. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301 (ACI 301M).
2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches (150 mm) into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

B. Inspections:

1. Steel reinforcement placement.
2. Verification of use of required design mixture.
3. Concrete placement, including conveying and depositing.

C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172/C 172M shall be performed according to the following requirements:
1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. (76 cu. m) or fraction thereof of each concrete mixture placed each day.

2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.

3. Air Content: ASTM C 231/C 231M, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F (4.4 deg C) and below or 80 deg F (27 deg C) and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C 31/C 31M.

    a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.

6. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.
    a. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
7. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi (3.4 MPa).
8. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
9. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Architect.
10. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
11. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

END OF SECTION

SECTION 323158

UNIT MASONRY FOR SCREEN WALL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Concrete masonry units.
2. Clay face brick.
3. Grout and anchoring cement (for decorative fence posts into top of CMU).
4. Cast Stone trim units.
5. Mortar and grout.
6. Steel reinforcing bars.
7. Masonry-joint reinforcement.
8. Miscellaneous masonry accessories.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete for Screen Wall Footings".

1.3 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).

B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For the following:

1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
2. Cast Stone Trim Units: Show sizes, profiles, and locations of each stone trim unit required.
3. Reinforcing Steel: Detail bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI 315. Show elevations of reinforced walls.

C. Samples for Initial Selection:
1. Clay face brick.
2. Special brick shapes.

3. Cast stone trim.
4. Accessories embedded in masonry.

D. Samples for Verification: For each type and color of the following:
1. Clay face brick.
2. Special brick shapes.
3. Cast stone trim.
4. Accessories embedded in masonry.

1.5 INFORMATIONAL SUBMITTALS

A. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply, and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates.

1. Submittal is for information only. Receipt of list does not constitute approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of Architect and approved in writing.

B. Qualification Data: For testing agency.

C. Material Certificates: For each type and size of the following:

1. Masonry units.

a. Include data on material properties.
b. For brick, include size-variation data verifying that actual range of sizes falls within specified tolerances.
c. For exposed brick, include test report for efflorescence according to ASTM C 67.
2. Cementitious materials. Include name of manufacturer, brand name, and type.
3. Mortar admixtures.
4. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
5. Grout mixes. Include description of type and proportions of ingredients.
6. Reinforcing bars.
7. Joint reinforcement.
8. Anchors, ties, and metal accessories.

D. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.

1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91/C 91M for air content.
2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

E. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to TMS 602/ACI 530.1/ASCE 6.

F. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM C 1093 for testing indicated.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
   1. Build mockups for typical exterior masonry screen wall in size approximately 48 inches (1200 mm) long by 36 inches (900 mm) high by full thickness, including face and backup wythes and accessories.

      a. Include a sealant-filled joint at least 16 inches (400 mm) long in mockup.
   2. Approval of mockups is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship.

      a. Approval of mockups is also for other material and construction qualities specifically approved by Architect in writing.
      b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

   3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.8 FIELD CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

   1. Extend cover a minimum of 24 inches (600 mm) down both sides of walls, and hold cover securely in place.

2. Where one wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches (600 mm) down face next to unconstructed wythe, and hold cover in place.

B. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.

1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.

2. Protect sills, ledges and projections from mortar droppings.

C. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F (4 deg C) and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.

D. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.

B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

2.2 PERFORMANCE REQUIREMENTS

A. Provide unit masonry that develops indicated net-area compressive strengths at 28 days.

2.3 UNIT MASONRY, GENERAL

A. Masonry Standard: Comply with TMS 602/ACI 530.1/ASCE 6, except as modified by requirements in the Contract Documents.

B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work.

2.4 CONCRETE MASONRY UNITS

A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.

1. Provide special shapes for lintels, corners, movement joints, headers, bonding, and other special conditions.
2. Provide square-edged units for outside corners unless otherwise indicated.

B. CMUs: ASTM C 90.
1. Density Classification: Normal weight unless otherwise indicated.
2. Size (Width): Manufactured to dimensions 3/8 inch (10 mm) less than nominal dimensions.

2.5 BRICK

A. General: Provide shapes indicated and as follows, with exposed surfaces matching finish and color of exposed faces of adjacent units:

1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
2. Provide special shapes for applications where stretcher units cannot accommodate special conditions, including those at corners, movement joints, bond beams, sashes, and lintels.
3. Provide special shapes for applications requiring brick of size, form, color, and texture on exposed surfaces that cannot be produced by sawing.
4. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.

B. Clay Face Brick: Facing brick complying with ASTM C 216.
1. Basis of Design Product: Subject to compliance with requirements, provide the following:
   a. Belden Tri-State Building Materials; Frisco Blend.
2. Grade: SW.
3. Type: FBS.
4. Initial Rate of Absorption: Less than 30 g/30 sq. in. (30 g/194 sq. cm) per minute when tested according to ASTM C 67.
5. Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated "not effloresced."
6. Size (Actual Dimensions): Type A: Utility size brick.
7. Application: Use where brick is exposed unless otherwise indicated.

8. Color and Texture: As selected by Architect.

2.6 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150/C 150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

1. Alkali content shall not be more than 0.1 percent when tested according to ASTM C 114.

B. Hydrated Lime: ASTM C 207, Type S.

C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

D. Mortar Cement: ASTM C 1329/C 1329M.

E. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C 979/C 979M. Use only pigments with a record of satisfactory performance in masonry mortar.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Davis Colors.
      b. Euclid Chemical Company (The); an RPM company.
      c. Lanxess Corporation.
      d. Solomon Colors, Inc.

F. Colored Cement Products: Packaged blend made from Portland cement and hydrated lime and mortar pigments, all complying with specified requirements, and containing no other ingredients.
   1. Colored Portland Cement-Lime Mix:
      a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
         1) Essroc.
         2) Holcim (US) Inc.
         3) Lafarge North America Inc.
         4) Lehigh Hanson; Heidelberg Cement Group
   2. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
   3. For the mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
   4. For joints less than ¼ inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.
   5. White-Mortar Aggregates: Natural white sand or crushed white stone.
   6. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

G. Aggregate for Mortar: ASTM C 144.

   1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
   2. For joints less than 1/4 inch (6 mm) thick, use aggregate graded with 100 percent passing the No. 16 (1.18-mm) sieve.
   3. White-Mortar Aggregates: Natural white sand or crushed white stone.
   4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

H. Aggregate for Grout: ASTM C 404.

I. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.

J. Water: Potable.

2.7 Grout and Anchoring Cement

A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout, recommended in writing by manufacturer, for exterior applications.

B. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating, and that is recommended in writing by manufacturer for exterior applications.

2.8 REINFORCEMENT

A. Uncoated-Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60 (Grade 420).

B. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and to hold reinforcing bars in center of cells. Units are formed from 0.148-inch (3.77-mm) steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Heckmann Building Products, Inc.
      b. Hohmann & Barnard, Inc.
      c. Wire-Bond.

C. Masonry-Joint Reinforcement, General: ASTM A 951/A 951M.
   1. Exterior Walls: Hot-dip galvanized carbon steel.
   2. Wire Size for Side Rods: 0.148-inch (3.77-mm) diameter.
   3. Wire Size for Cross Rods: 0.148-inch (3.77-mm) diameter.
   4. Wire Size for Veneer Ties: 0.148-inch (3.77-mm) diameter.
   5. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches (407 mm) o.c.
   6. Provide in lengths of not less than 10 feet (3 m), with prefabricated corner and tee units.

D. Masonry-Joint Reinforcement for Multi-wythe Masonry:

   1. Ladder type with one side rod at each face shell of hollow masonry units more than 4 inches (100 mm) wide, plus one side rod at each wythe of masonry 4 inches (100 mm) wide or less.
   2. Tab type, either ladder or truss design, with one side rod at each face shell of backing wythe and with rectangular tabs sized to extend at least halfway through facing wythe, but with at least 5/8-inch (16-mm) cover on outside face.
   3. Adjustable (two-piece) type, either ladder or truss design, with one side rod at each face shell of backing wythe and with separate adjustable ties with pintle-and-eye connections having a maximum horizontal play of 1/16 inch (1.5 mm) and maximum vertical adjustment of 1-1/4 inches (32 mm). Size ties to extend at least halfway through facing wythe but with at least 5/8-inch (16-mm) cover on outside face. Ties have hooks or clips to engage a continuous horizontal wire in the facing wythe.

2.9 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene urethane or PVC.

2.10 MASONRY CLEANERS

A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

2.11 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. Use portland cement-lime or mortar cement mortar unless otherwise indicated.
3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated.

1. For masonry below grade or in contact with earth, use Type M.
2. For reinforced masonry, use Type M or Type S.
3. For exterior, above-grade, load-bearing and nonload-bearing walls and parapet walls; and for other applications where another type is not indicated, use Type N.

D. Pigmented Mortar: Use colored cement product.
1. Mix to match Architect’s sample.
2. Application: Use pigmented mortar to exposed mortar joints with the following units:
   a. Clay face brick.
   b. Cast-stone trim units.

E. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.
1. Mix to match Architect’s sample.
2. Application: Use colored-aggregate mortar for exposed mortar joints with the following units:
   a. Clay face brick.
   b. Cast-stone trim units.

F. Grout for Unit Masonry: Comply with ASTM C 476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with TMS 602/ACI 530.1/ASCE 6 for dimensions of grout spaces and pour height.
2. Proportion grout in accordance with ASTM C 476, Table 1 or paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2000 psi (14 MPa)].
3. Provide grout with a slump of 8 to 11 inches (200 to 280 mm) as measured according to ASTM C 143/C 143M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
   1. Verify that foundations are within tolerances specified.
   2. Verify that reinforcing dowels are properly placed.
   3. Verify that substrates are free of substances that impair mortar bond.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.

B. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match construction immediately adjacent to opening.

C. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

D. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures. Mix units from several pallets or cubes as they are placed.

E. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. (30 g/194 sq. cm) per minute when tested according to ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.

3.3 TOLERANCES

A. Dimensions and Locations of Elements:

   1. For dimensions in cross section or elevation, do not vary by more than plus 1/2 inch (12 mm) or minus 1/4 inch (6 mm).
   2. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch (12 mm).
   3. For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4 inch (6 mm) in a story height or 1/2 inch (12 mm) total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls, do not vary from level by more than 1/4 inch in 10 feet (6 mm in 3 m), or 1/2-inch (12-mm) maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2-inch (12-mm) maximum.
3. For vertical lines and surfaces, do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2-inch (12-mm) maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2-inch (12-mm) maximum.
5. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2-inch (12-mm) maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), or 1/2-inch (12-mm) maximum.
7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch (1.5 mm) except due to warpage of masonry units within tolerances specified for warpage of units.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm), with a maximum thickness limited to 1/2 inch (12 mm).
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch (3 mm).
3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch (9 mm) or minus 1/4 inch (6 mm).
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm). Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch (3 mm).
5. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch (1.5 mm) from one masonry unit to the next.

3.4 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less-than-nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.

C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 2 inches (100 mm). Bond and interlock each course of each wythe at corners. Do not use units with less-than-nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

F. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below, and rod mortar or grout into core.

G. Fill cores in hollow CMUs with grout 24 inches (600 mm) under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

3.5 MORTAR BEDDING AND JOINTING

A. Lay hollow masonry units as follows:

1. Bed face shells in mortar and make head joints of depth equal to bed joints.
2. Bed webs in mortar in all courses of piers, columns, and pilasters.
3. Bed webs in mortar in grouted masonry, including starting course on footings.
4. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.
5. Fully bed units and fill cells with mortar at anchors and ties as needed to fully embed anchors and ties in mortar.

B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Set cast-stone trim units in full bed of mortar with full vertical joints. Fill dowel, anchor, and similar holes.

1. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water.
2. Allow cleaned surfaces to dry before setting.
3. Wet joint surfaces thoroughly before applying mortar.
4. Rake out mortar joints for pointing with sealant.

D. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

3.6 COMPOSITE MASONRY

A. Bond wythes of composite masonry together using one of the following methods as follows:

1. Individual Metal Ties: Provide ties as shown installed in horizontal joints, but not less than one metal tie for 1.77 sq. ft. (0.16 sq. m) of wall area spaced not to exceed 16 inches (406 mm) o.c. horizontally and 16 inches (406 mm) o.c. vertically. Stagger ties in alternate courses. Provide additional ties within 12 inches (305 mm) of openings and space not more than 36 inches (914 mm) apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than 24 inches (610 mm) o.c. vertically.

   a. Where bed joints of wythes do not align, use adjustable-type (two-piece-type) ties.

2. Masonry-Joint Reinforcement: Installed in horizontal mortar joints.

a. Where bed joints of wythes align, use ladder-type reinforcement extending across wythes.
b. Where bed joints of wythes do not align, use adjustable-type (two-piece-type) reinforcement with continuous horizontal wire in facing wythe attached to ties.

B. Bond wythes of composite masonry together using bonding system indicated on Drawings.

C. Corners: Provide interlocking masonry unit bond in each wythe and course at corners unless otherwise indicated.

1. Provide continuity with masonry-joint reinforcement at corners by using prefabricated L-shaped units as well as masonry bonding.

D. Intersecting and Abutting Walls: Unless vertical expansion or control joints are shown at juncture, bond walls together as follows:

1. Provide individual metal ties not more than 16 inches (406 mm) o.c.
2. Provide continuity with masonry-joint reinforcement by using prefabricated T-shaped units.
3. Provide rigid metal anchors not more than 24 inches (610 mm) o.c. If used with hollow masonry units, embed ends in mortar-filled cores.

3.7 MASONRY-JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch (16 mm) on exterior side of walls, 1/2 inch (13 mm) elsewhere. Lap reinforcement a minimum of 6 inches (150 mm).

1. Space reinforcement not more than 16 inches (406 mm) o.c.
2. Provide reinforcement not more than 8 inches (203 mm) above and below wall openings and extending 12 inches (305 mm) beyond openings in addition to continuous reinforcement.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

E. Cut and bend reinforcing units as directed by manufacturer for continuity at corners, returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.8 CONTROL AND EXPANSION JOINTS

A. General: Install control- and expansion-joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.

B. Provide control joints in exterior masonry in the following locations:
1. Within 5 feet of exterior corners and not more than 22’-8” on center.
2. Final location of control joints shall be verified with the Architect.

C. Form control joints in concrete masonry using one of the following methods:

1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout, and rake out joints in exposed faces for application of sealant.
2. Install preformed control-joint gaskets designed to fit standard sash block.
3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar, or rake out joint for application of sealant.
4. Install temporary foam-plastic filler in head joints, and remove filler when unit masonry is complete for application of sealant.

D. Form expansion joints in brick as follows:

1. Build flanges of metal expansion strips into masonry. Lap each joint 4 inches (100 mm) in direction of water flow. Seal joints below grade and at junctures with horizontal expansion joints if any.
2. Build flanges of factory-fabricated, expansion-joint units into masonry.
3. Build in compressible joint fillers where indicated.
4. Form open joint full depth of brick wythe and of width indicated, but not less than 3/8 inch (10 mm) for installation of sealant and backer rod specified in Section 079200 "Joint Sealants."

E. Do not continue horizontal joint reinforcement through control or expansion joints.

F. Install preformed control joint device in continuous lengths. Seal butt and corner joints in accordance with manufacturer’s instructions.

3.9 REINFORCED UNIT MASONRY INSTALLATION

A. Placing Reinforcement: Comply with requirements in TMS 602/ACI 530.1/ASCE 6.

B. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1. Comply with requirements in TMS 602/ACI 530.1/ASCE 6 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
2. Limit height of vertical grout pours to not more than 48 inches.

3.10 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.

B. Inspections: Special inspections according to Level B in TMS 402/ACI 530/ASCE 5.

C. Testing Prior to Construction: One set of tests.

D. Testing Frequency: One set of tests for each 5000 sq. ft. (464 sq. m) of wall area or portion thereof.

E. Clay Masonry Unit Test: For each type of unit provided, according to ASTM C 67 for compressive strength.

F. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C 140 for compressive strength.

G. Mortar Test (Property Specification): For each mix provided, according to ASTM C 780. Test mortar for mortar air content and compressive strength.

H. Grout Test (Compressive Strength): For each mix provided, according to ASTM C 1019.

3.11 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
6. Clean concrete masonry by applicable cleaning methods indicated in NCMA TEK 8-4A.
7. Clean cast stone trim to comply with supplier's written instructions.

3.12 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.

1. Crush masonry waste to less than 4 inches (100 mm) in each dimension.
2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Section 312000 "Earth Moving."
3. Do not dispose of masonry waste as fill within 18 inches (450 mm) of finished grade.

C. Masonry Waste Recycling: Return broken CMUs not used as fill to manufacturer for recycling.

D. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION

SECTION 323313
BICYCLE RACKS

PART 1 - GENERAL

1.1 DESCRIPTION

A. General: Supply and install bicycle racks in the locations shown on the Plans.

1.2 SUBMITTALS

A. Submit manufacturer's product data and setting drawings in accordance with the conditions of the contract.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Protect racks and accessories from damage and in accordance with manufacturer's instructions during delivery, storage, and handling.

1.4 SUBMITTALS

A. Manufacturer's warranty shall agree to repair, replace, or refund the purchase price of bicycle racks found defective. Material and workmanship shall be warranted for five years. Coatings shall be warranted for two years against peeling, cracking, and color change.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Steel

1. Pipe: ASTM A53, Type F or Type S, Grade A
2. Plate, Shape, and Bars: ASTM A36
3. Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions.

B. Fabrication

1. Fabricate units with welded connections.
2. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
3. Provide inserts and other anchorage devices for connecting bicycle racks to substrate.
4. Protect finished from damage before shipping.
5. Exposed fasteners and accessories shall be stainless steel.

C. Bicycle racks shall be as manufactured by Reliance Foundry, Sportworks Northwest Inc., or approved equal with inverted U form, steel construction, textured black color, and shall be a flange mounted installation.

2.2 ACCESSORIES

A. Mounting Accessories

1. Epoxy adhesive: As recommended in writing by adhesive manufacturer for outdoor use with concrete and steel.
2. Fasteners:
   a. 1/2 inch UNC Button Head Bolts, c/w SS Washer.
   b. Drop in place concrete anchors, for 1/2 inch UNC bolts.
3. Sealant: Silicone elastomeric sealant recommended for outdoor use.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine paving or other substrates for compliance with manufacture's requirements for placement and installation, condition of substrate, and other conditions affecting installation of bicycle racks.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install according to manufacturer's written instructions for flange mounted installation.

B. Do not install damaged, cracked, chipped, deformed, or marred bicycle racks.

3.3 PROTECTION

A. Clean installed racks in accordance with manufacturer's written instructions to remove dust, dirt, adhesives, and other foreign material.

END OF SECTION

SECTION 329000

PLANTING

PART 1 – GENERAL

1.1 DESCRIPTION AND REQUIREMENTS

A. This work consists of furnishing and installing all planting materials required for landscaping. The landscape contractor shall be required to visit the site prior to submitting Bid Proposal to become familiar with all conditions affecting the proposed work. The contractor shall identify and review all underground utility locations prior to commencing work and shall exercise caution when working close to utilities and shall notify the Owner's Representative of apparent conflicts with construction and utilities so that adjustment can be planned prior to installation.

B. Agronomic consultation on the appropriateness of all plant materials proposed for installation during this project must be obtained from the State Agronomist and/or via coordination through the Owner's Representative prior to project initiation and actual plant installation. In general, all plant material must be regionally adapted to the climate of the site, be of appropriate mature dimensions to fit the planting location and be low maintenance species. This requirement will generally exclude or severely limit the use of rose plants, wild flowers and ground covers.

C. Any exceptions to these species exclusions must be approved by the State Agronomist via coordination through the Owner's Representative prior to project initiation.

1.2 EQUIPMENT

A. Maintain all equipment, tools and machinery while on the project in sufficient quantities and capacity for proper execution of the work.

1.3 RELATED WORK

A. Section 31 10 00, SITE CLEARING
B. Section 31 20 00, EARTH MOVING

1.4 SUBMITTALS

A. Samples: Submit the following samples for approval before work is started:

Inert Mulch	5 pounds of each type to be used.
All pesticides required such as preemergence or post emergence herbicides, insecticides, or fungicides.	EPA approved labeling and MSDS sheet for each such product selected for use.

B. Certificates of Conformance or Compliance: Before delivery, notarized certificates attesting that the following materials meet the requirements specified shall be submitted to the Owner's Representative for approval:

1. Plant Materials (Department of Agriculture certification by State Nursery Inspector from the state in which the plant material originates declaring material to be free from insects and disease).
2. Fertilizers
3. Lime
4. Peat
5. Seed
6. Sod
7. Membranes
8. Asphalt Adhesive

C. Manufacturer's Literature and Data:
1. Metal edging
2. Antidesiccant
3. Erosion control materials
4. Hydro mulch
5. Pre-emergent herbicide

D. Licenses: Licenses of Arborist shall be submitted (one copy), to the Owner's Representative.

E. Seed: Submit a manufacturer's Certificate of Compliance to the Specifications with each shipment of each type of seed. These certificates shall include the guaranteed percentages of purity, weed content and germination of the seed, and also the net weight and date of shipment. No seed may be sown until the Contractor has submitted the certificates.

F. Fertilizer: Submit a certificate of analysis for each type of fertilizer.

G. Hydro Mulching: Prior to the start of hydro mulching, submit a certified statement for approval as to the number of pounds of materials to be used per gallon of water.

1.5 DELIVERY AND STORAGE

A. Delivery:
1. Notify the Owner's Representative of the delivery schedule in advance so the plant material may be inspected upon arrival at the job site. Remove unacceptable plant material from the job site immediately.
2. Protect plants during delivery to prevent damage to root balls or desiccation of leaves. Protect trees during transport by tying in the branches and covering all exposed branches.
3. The use of equipment such as "tree spades" is permitted provided the plant balls are sized in accordance with ANSI Z60.1 and tops are protected from damage.
4. Deliver fertilizer and lime to the site in the original, unopened containers bearing the manufacturer's warranted chemical analysis, name, trade name or trademark, and in conformance to state and federal law. In lieu of containers, fertilizer and lime may be furnished in bulk and a certificate indicating the above information shall accompany each delivery.
5. During delivery: Protect sod from drying out and seed from contamination.

B. Storage:
1. Sprinkle sod with water and cover with moist burlap, straw or other approved covering, and protect from exposure to wind and direct sunlight. Covering should permit air circulation to alleviate heat development.
2. Keep seed, lime, and fertilizer in dry storage away from contaminants.
3. Store plants not installed on the day of arrival at the site as follows:
   a. Shade and protect plants from the wind when stored outside.
   b. Heel in bare root plants.

c. Protect plants stored on the project from drying out at all times by covering the balls or roots with moist sawdust, wood chips, shredded bark, peat moss, or other similar mulching material.
d. Keep plants, including those in containers, in a moist condition until planted, by watering with fine mist spray.

1.6 PLANTING AND TURFGRASS INSTALLATION SEASONS AND CONDITIONS

A. Perform landscape planting operations within the following dates, but not before irrigation system installed, tested, and approved.
   1. Spring Planting: March 1st to June 30th.
   2. Fall Planting: September 1st to November 15th.

B. Perform turfgrass installation operations within the dates specified on the Plans, but not before irrigation system installed, tested, and approved.

C. No work shall be done when the ground is frozen, snow covered, too wet or in an otherwise unsuitable condition for planting. Special conditions may exist that warrants a variance in the specified planting dates or conditions. Submit a written request to the Owner's Representative stating the special conditions and proposal variance for approval.

1.7 LANDSCAPE PLANT AND TURF ESTABLISHMENT PERIOD

A. The Establishment Period for landscape plants and turfgrass shall begin immediately after installation, with the approval of the Owner's Representative and continue for a period of time during the growing season sufficiently long (optimally a minimum of 3 months) for the turfgrass and landscape plant materials to achieve an establishment condition and appearance satisfactory to the State Agronomist and NCA. These conditions and appearance are described as follows: Turfgrass shall have obtained a minimum of 98% surface cover that is generally weed-free and Landscape Plant Materials shall be fully rooted, actively growing and healthy and planting beds generally weed-free. The contractor shall be responsible for the health and maintenance of plants and turfgrass during the establishment period. Plants and turfgrass will not be accepted until after completion of an acceptable establishment period. During the Landscape Plant and TurfGRASS Establishment Period the Contractor shall:
   1. Water all plants and turfgrass to maintain a moist soil surface at all times until the plants and turfgrass are well established. An adequate supply of moisture must also be maintained within the root zone. Apply water at a moderate rate so as not to displace the mulch, create any water ponding or runoff from the soil supporting the plants and turfgrass. The actual quantity of applied water required to achieve and maintain these conditions is best determined on site by the State Agronomist in consultation with the Owner's Representative.
   2. Prune plants and replace mulch as required.
   3. Replace and restore stakes, guy straps, and eroded plant saucers as required.
   4. In plant beds and saucers, remove grass, weeds, and other undesired vegetation, including the root growth, before they reach a height of 3 inches. After all unwanted vegetation has been removed and proper mulch quantities have been placed/restored, treat all mulched areas with pre-emergence granular ornamental herbicide containing 2.0% trifluralin and 0.5% isoxaben. Apply at 200 lb per acre prior to both early spring and early fall weed seed germination.
   5. Spray with approved insecticides and fungicides to control pests and ensure plant survival in a healthy growing condition, as directed by the Owner's Representative in coordination with the State Agronomist.
   6. Provide the following during turfgrass establishment:
      a. Eradicate all weeds. Water, fertilize, overseed, and perform any other operation necessary to promote the growth of turfgrass.

b. Mow the turfgrasses as often as necessary to maintain the specified mowing height for each type of turfgrass prior to final acceptance. Begin mowing when cool season turfgrass is 4 inches high. For warm season turfgrasses mow at heights as appropriate for species and cultivar as directed by the Owner's Representative in consultation with the State Agronomist. Final mowing height is 3.0 inches for cool season turfgrasses and as appropriate for warm season turfgrasses and mow as often as necessary to maintain the proper height while never removing more than 1/3 of the total height of grass leaves in a single mowing. Mow any portion of the newly developing turfgrass stand that requires mowing without waiting for other areas of slowly developing seedlings to catch-up.

7. Replace dead, missing or defective plant material during the establishment period and an active growing season. Immediately replace each plant with one of the same size and species.
8. Replant any areas void of turfgrass during an active growing season only.
   a. Sod shall be evaluated for species and health thirty (30) days after laying the last piece of sod and reevaluated each 15 days during the establishment period. A satisfactory stand of grass plants from the sod operation shall be living sod uniform in color and leaf texture. Bare spots shall be a maximum two (2) square inches. Joints between sod pieces shall be tight and free from weeds and other undesirable growth.
   b. Seeding shall be evaluated for species and health thirty (30) days after final planting and reevaluated each 15 days during the establishment period. A satisfactory stand of grass plants from the seeding operation shall be 98% coverage uniform in color and leaf texture. Bare spots shall be a maximum of one-half (0.5) square foot. Unsatisfactory areas shall be reseeded within seven (7) days during an active growing season.
9. Complete remedial measures directed by the Owner's Representative in consultation with the State Agronomist to ensure plant and turfgrass survival.
10. Repair damage caused while making plant or turfgrass replacements.

1.8 LANDSCAPE PLANT AND TURFGRASS ACCEPTANCE.

A. Landscape plant and turfgrass acceptance will occur after completion of the LANDSCAPE PLANT AND TURFGRASS ESTABLISHMENT PERIOD. The Contractor shall have completed, located, and installed all plants and turfgrass according to the plans and specifications. All plants and turfgrass are expected to be living and in a healthy condition at the time of inspection and acceptance. The Contractor shall make a written request two weeks prior to final inspection of the landscape plants and turfgrass. Upon inspection when work is found to not meet the specifications, the PLANT AND TURFGRASS ESTABLISHMENT PERIOD shall be extended at no additional cost to the Government until work has been satisfactorily completed, inspected and accepted.

B. Criteria for acceptance of landscape plants.
   1. Planter beds and earth mound water basins are properly mulched and free of weeds.
   2. Tree support stakes, guys, and turnbuckles are in good condition.
   3. Total plants on site as required by specifications and required number of replacements have been installed.
   4. Remedial measures directed by the Contracting Officer to ensure plant material survival and promote healthy growth have been completed.

C. Criteria for acceptance of turfgrass shall be as follows:
   1. A satisfactory stand of grass plants from the sod operation shall be living sod uniform in color and leaf texture and well rooted into the soil below so that gentle pulling of the turfgrass leaves by hand does not dislodge the sod. Bare spots shall be a maximum two (2) square inches. Joints between sod pieces shall be tight and free from weeds and other undesirable growth.
   2. A satisfactory stand of turfgrass plants from the seeding operation shall be 98% coverage uniform in color and leaf texture. Bare spots shall be a maximum of one-half (0.5) square foot.

1.9 PLANT AND TURFGRASS WARRANTY

A. All work shall be in accordance with the following:
   1. A One Year Plant and Turfgrass Warranty will begin on the date that the Government accepts the plants and turfgrass but not before the end of the Landscape Plant and Turfgrass Establishment Period.
   2. The Contractor will replace any dead plant material and any areas void of turfgrass immediately during the warranty period and during an active growing season. A one year warranty for the plants and turfgrass that are replaced will begin on the day the replacement work is completed and accepted.
   3. Replacement of relocated plants, that the Contractor did not supply, is not required unless they die from improper handling and care during transplanting. Loss through Contractor improper handling, care, or negligence requires replacement in kind and size.
   4. The State will reinspect all replacement plants and turfgrass at the end of the One Year Warranty. The Contractor will replace any dead, missing, or defective plant material and turfgrass immediately and during an active growing season. The Warranty will end on the date of this inspection provided the Contractor has complied with the work required by this specification.
   5. The Contractor shall remove stakes, guy straps and any required tree wrappings from plants having been installed for one year, unless otherwise directed by the Owner's Representative in consultation with the State Agronomist.

1.10 APPLICABLE PUBLICATIONS

A. NCA Handbook 3420 – Turfgrass Maintenance in VA National Cemeteries re-certified 2011. The Agronomic and Horticultural practices specified in this handbook shall serve as the contractor's official reference guide to all establishment and preliminary maintenance practices employed during this construction project.
B. The publications listed below, form a part of this specification to the extent referenced. The publications are referenced in the text by basic designation only.
C. American National Standards Institute (ANSI) Publications:
   ANSI Z60.1-04 ..... Nursery Stock
   ANSI Z133.1-06 ..... Tree Care Operations-Pruning, Trimming, Repairing, Maintaining, and Removing Trees and Cutting Brush- Safety Requirements
D. Hortus Third, most current edition. A Concise Dictionary of Plants Cultivated in the U.S. and Canada.
E. American Society for Testing and Materials (ASTM) Publications:
   C136-06 ..... Sieve Analysis of Fine and Coarse Aggregates
   C516-08 ..... Vermiculite Loose Fill Thermal Insulation
   C549-06 ..... Perlite Loose Fill Insulation
   D977-05 ..... Emulsified Asphalt (AASTHO M140)
   D1557-09 ..... Test Methods for Laboratory Compaction of Soil
   D2028-97 (Rev. 2004) ..... Cutback Asphalt (Rapid-curing Type)
   D2103-08 ..... Polyethylene Film and Sheeting
   D5851 (Rev 2006) ..... Planning and Implementing a Water Monitoring Program
F. Turfgrass Producers International:Turfgrass Sodding.
G. U. S. Department of Agriculture Federal Seed Act.
   Amended July 2011 ..... Rules and Regulations

PART 2 - PRODUCTS

2.1 GENERAL

All plant and turfgrass material will conform to the varieties specified or shown in the plant list and be true to botanical name as listed in Hortus Third.

2.2 PLANTS

A. Plants shall be in accordance with ANSI Z60.1, except as otherwise stated in the specifications or shown on the plans. Where the drawings or specifications are in conflict with ANSI Z60.1, the drawings and specification shall prevail.
B. Provide well-branched and formed planting stock, sound, vigorous, and free from disease, sunscald, windburn, abrasion, harmful insects or insect eggs with healthy, normal, and unbroken root systems. Provide trees, deciduous and evergreen, that are single trunked with a single leader, unless otherwise indicated, display no weak crotches. Provide symmetrically developed deciduous trees and shrubs of uniform habit of growth, with straight boles or stems and free from objectionable disfigurements, and evergreen trees and shrubs with well developed symmetrical tops with typical spread of branches for each particular species or variety. Provide ground cover and vine plants with the number and length of runners for the size specified, and the proper age for the grade of plants specified. Provide vines and ground cover plants well established in removable containers, integral containers, or formed homogeneous soil sections. Plants shall have been grown under climatic conditions similar to those in the locality of the project.
C. The minimum acceptable sizes of all plants, measured before pruning with branches in normal position, shall conform to the measurements designated. Plants larger in size than specified may be used with the approval of the Owner's Representative, with no change in the contract price. When larger plants are used, increase the ball of earth or spread of roots in accordance with ANSI Z60.1.
D. Provide nursery grown, Grade 1, plant material conforming to the requirements and recommendations of ANSI Z60.1. Dig and prepare plants for shipment in a manner that will not cause damage to branches, shape, and future development after planting. Never pick-up or move tree species by grasping the trunk. Trees must be moved by lifting the root ball, box or container.
E. Balled and burlapped (B&B) plant ball sizes and ratios will conform to ANSI Z60.1, consisting of firm, natural balls of soil wrapped firmly with burlap or strong cloth and tied.
F. Bare-root (BR) plants shall have the root system substantially intact, but with the earth carefully removed. Cover roots with a thick coating of mud by "puddling" after the plants are dug.
G. Container grown plants shall have sufficient root growth to hold the earth intact when removed from containers, but shall not be root bound.
H. Make substitutions only when a plant (or its alternates as specified) is not obtainable and the Owner's Representative in consultation with the State Agronomist authorizes a change order providing for use of the nearest equivalent obtainable size or variety of plant having the same essential characteristics with an equitable adjustment of the contract price.
I. When existing plants are to be relocated, ball sizes shall conform to requirements for collected plants in ANSI Z60.1, and plants shall be dug, handled, and replanted in accordance with applicable sections of these specifications.

2.3 LABELS

A. Each plant, or group and bundles or containers of the same species, variety, and size of plant, shall be legibly tagged with a durable, waterproof and weather-resistant label indicating the correct plant name and size specified in the plant list. Labels shall be securely attached and not be removed.

2.4 TOPSOIL

A. Topsoil shall be as specified in Section 31 20 00: EARTHMOVING

2.5 LIME

A. Lime shall be agricultural limestone containing not less than 90 percent calcium and magnesium carbonates. Lime must be ground to such fineness that not less than 90% must pass No. 8 mesh and not less than 25% must pass No. 100 mesh. Moisture is not to exceed 10%.

2.6 SOIL CONDITIONERS

A. Peat shall be a natural product of sphagnum moss peat, peat moss, or hypnum moss derived from a fresh-water site conforming to Fed. Spec. Q-P-166, except as otherwise specified. Peat shall be shredded and granulated to pass through a 1/2 inch mesh screen and conditioned in storage piles for at least six months after excavation.
B. Coarse Sand: Coarse concrete sand, ASTM C-33 Fine Aggregate, shall be clean, sharp, and free of limestone, shale and slate particles and of toxic materials.
C. Perlite shall conform to ASTM C549.
D. Vermiculite shall be horticultural grade and free of any toxic materials and conform to ASTM C516.
E. Pine Bark shall be horticultural-grade milled pine bark, with 80 percent of the material by volume sized between .004in. and .59in.
   1. Pine bark shall be aged sufficiently to break down all woody material. Pine bark shall be screened.
   2. pH shall range between 4.0 and 7.0.
   3. Submit manufacturer’s literature for approval.
F. Organic Matter shall be commercially prepared compost, composted sufficiently to be free of all woody fibers, seeds, and leaf structures, and free of toxic and nonorganic matter.

2.7 PLANTING SOIL MIXTURE

A. The planting soil mixture shall be composed of 3 parts topsoil, and 1 part peat moss.

2.8 PLANT FERTILIZERS

A. Provide plant fertilizer that is commercial grade and uniform in composition and conforms to applicable state and federal regulations.

B. For new plant material, provide a uniform free-flowing granular complete analysis fertilizer containing a minimum of 10% by weight of nitrogen, phosphoric acid and potash with a minimum of 50% of the nitrogen from a controlled release source such as sulfur coated urea.

C. For existing trees, provide a uniform free-flowing granular fertilizer bearing the manufacturer's warranted statement of analysis. Granular fertilizer shall contain a minimum percentage by weight of 10% nitrogen (of which 50 percent shall be from a controlled release source such as sulfur coated urea.), 10% available phosphoric acid, and 10% potash.

2.9 TURFGRASS FERTILIZER

Provide turfgrass fertilizer that is commercial grade, free flowing, uniform in composition, and conforms to applicable state and federal regulations. Granular and liquid fertilizer shall bear the manufacturer's warranted statement of analysis. Granular fertilizer shall contain a minimum percentage by weight of 20% nitrogen (of which 50 percent shall be from a controlled release source such as sulfur coated urea), 5% available phosphoric acid, and 15% potash. Liquid starter

fertilizer for use in the hydro mulch slurry will be commercial type with 50 percent of the nitrogen from a controlled release source. Apply at the following rates:

A. 25.0 pounds ground limestone per 1,000 square feet
B. 3.0 pounds muriate of potash (0-0-60) per 1,000 square feet
C. 1.5 pounds of 32-3-10 or equivalent water soluable fertilizer per 1,000 square feet
D. 1.0 pound of Nitrogen per 1,000 square feet

2.10 MULCH

A. Mulch shall be free from deleterious materials and shall be stored as to prevent inclusion of foreign material.
B. Inert mulch materials shall be riverbank stone, granite chips, marble chips, volcanic rock or similar and shall range in size from one inch to 2-1/2 inches in accordance with ASTM C 136.
C. Organic mulch materials shall be as follows:
   1. Straw for turfgrass seed bed mulch shall be stalks from oats, wheat, rye, barley, or rice that are free from noxious weeds, mold or other objectionable material. Straw shall be in an air-dry condition and suitable for placing with blower equipment.
   2. Wood cellulose fiber mulch for use with hydraulic application (Hydro mulch) with fertilizer shall consist of specially prepared wood cellulose fiber, processed to contain no growth or germination-inhibiting factors, and dyed an appropriate color to facilitate visual metering of the application of materials. Do not apply any turfgrass seed in this type mixture. On an air-dry weight basis, the wood cellulose fiber shall contain a maximum of 12 percent moisture, plus or minus three percent at the time of manufacture. The pH range shall be from 3.5 to 5.0. The wood cellulose fiber shall be manufactured so that:
      a. After addition and agitation in slurry tanks with fertilizers, water, and other approved additives, the fibers in the material will become uniformly suspended to form a homogenous slurry.
      b. When hydraulically sprayed on the ground, the material will form a blotter like cover.
      c. The cover will allow the absorption of moisture and allow rainfall or applied water to percolate to the underlying soil.

2.11 ASPHALT ADHESIVE

A. Asphalt adhesive for application with straw mulch shall be liquid asphalt conforming to ASTM D2028, designation RC-70, or emulsified asphalt conforming to ASTM D977, Grade RS-1.

2.12 EROSION CONTROL

A. Refer to Section 31 25 00 EROSION AND SEDIMENT CONTROLS

2.13 STAKES AND GUYING STRAPS

A. Provide stakes for tree support as indicated on the Contract Drawings. Stakes shall be a minimum 3 inches in diameter, 8 feet long and pointed at one end.
B. Hose chafing guards shall be new or used 2-ply reinforced rubber or plastic hose of all the same color on the project.
C. Guying straps shall be a fabric material designed specifically to guy newly planted trees. No wire should ever be used for this purpose.
D. Turnbuckles shall be galvanized or cadmium-plated and have a 3 inch minimum lengthwise opening fitted with screw eyes.

2.14 EDGING

A. As a general requirement no artificial or constructed product shall be used to edge landscape beds that are bordered by turfgrass. Any deviation from this requirement must be approved by the Owner's Representative after consultation with both the State Agronomist. Properly mulched beds shall be edged by the newly established turfgrass plantings that border and/or surround them.

2.15 WATER

A. Water shall not contain elements toxic to plant life.

2.16 ANTIDESICCANT

A. Antidesiccant shall be an emulsion specifically manufactured for agricultural use that will provide a protective film over plant surfaces permeable enough to permit transpiration.

2.17 SEED

A. Seed shall be state-certified seed of the latest season's crop and shall be delivered in original sealed packages bearing the producer's warranted analysis for percentages of mixtures, purity, germination, weed seed content, and inert material. Seed shall be labeled in conformance with U. S. Department of Agriculture rules and regulations under the Federal Seed Act and applicable state seed laws. Seed that has become wet, moldy, or otherwise damaged will not be acceptable. Onsite seed mixing shall be done only in the presence of the Owner's Representative. All turfgrass seeding operations shall be done separately and prior to the application of any mulch material.
B. Minimum Acceptable Seed Quality standards for all turfgrass seed utilized are as follows: Purity 95%, Germination 85%, Weed Seed Content less than 0.5%, Noxious Weeds 0.0%, Inert Material less than 3%, Germination Test Date no older than 6 months.
C. All turfgrass seed mixtures, or sod composition shall conform to the species and cultivar requirements detailed on the Plans.

2.18 SOD

A. Sod shall be nursery grown, certified sod as classified in the TPI Guideline Specifications to Turfgrass Sodding. Sod must also conform to the turfgrass species limitations as outlined in seeding mixtures on the Plans.

2.19 HERBICIDES AND OTHER PESTICIDES

A. All herbicides and other pesticides shall be properly labeled and registered with the U.S. Environmental Protection Agency. Keep all pesticides in the original labeled containers indicating the analysis and method of use.

PART 3 – EXECUTION

3.1 LAYOUT

A. Stake plant material locations and bed outlines on project site for approval by the Owner's Representative before any plant pits or beds are dug. The Owner's Representative may approve adjustments to plant material locations to meet field conditions.

3.2 EXCAVATION FOR PLANTING

A. The whole surface shall then be compacted with a roller or other suitable means to achieve a maximum dry density of 88 to 90 percent in accordance with compaction standards of ASTM D1557 Method D. During the compaction process, all depressions caused by settlement or rolling shall be filled with additional organic soil amendment and the surface shall be regraded and rolled until presenting a smooth and even finish corresponding to the required grades. The acceptable condition of the finished soil grade for all areas that are to be established to turfgrass is best described as "**fine textured and firm". The test for satisfactory firmness requires that the surface soil not be fluffy or powdery and will support the weight of an average adult person without creating a visible depression.**

B. Prior to excavating for plant pits and bed, verify the location of any underground utilities. Damage to utility lines will be repaired at the Contractor's expense. Where lawns have been established prior to planting operation, cover the surrounding turfgrass before excavations are made in a manner that will protect turfgrass areas. Barricade existing trees, shrubbery, and beds that are to be preserved in a manner that will effectively protect them during the project construction.

C. Remove rocks and other underground obstructions to a depth necessary to permit proper planting according to plans and specifications. Where underground utilities, construction, or solid rock ledges are encountered, the Owner's Representative may select other locations for plant material.

D. Dig plant pits by any approved method so that they have vertical sides and flat bottoms. When pits are dug with an auger and the sides of the pits become glazed, scarify the glazed surface.

E. Where ground cover and planting beds occur in existing turfgrass areas, remove turfgrass to a depth that will ensure the removal of the entire root system, with additional bed preparation as specified in the next paragraph.

F. Where existing soil is to be used in place, till new ground cover and plant beds to a depth of 4 inches. Spread peat soil amendment uniformly over the bed to depth of 2 inches and thoroughly incorporate it into the existing soil to a depth of 4 inches using a roto-tiller or similar type of equipment to obtain a uniform and well pulverized soil mix. Where existing soil is compacted (former roadways, parking lots, etc.) till the soil down to a depth necessary to support the growth of new planting. During tillage operations, remove all sticks, stones, roots, and other objectionable materials. Bring plant beds to a smooth and even surface conforming to established grades.

G. In areas of new grading where existing soil is being replaced for the construction of new ground cover and plant beds, remove four inches (4") of existing soil and replace with topsoil. Plant beds shall be brought to a smooth and even surface conforming to established grades. Till two inches (2") of peat soil amendment into the topsoil as specified.

H. Using topsoil, form earth saucers or water basins for watering around plants. Basins to be two inches (2") high for shrubs and four inches (4") high for trees.

I. Treat plant saucers, shrub, and ground cover bed areas, after mulching, with preemergence granular ornamental herbicide containing 2.0% trifluralin and 0.5% isoxaben. Apply at 200 lb per acre prior to both early spring and early fall weed seed germination. Plant ground cover in areas to receive erosion control material through that material after material is in place.

3.3 SETTING PLANTS

A. Handle balled and burlapped and container-grown plants only by the ball or container. Remove container-grown plants in such a way to prevent damage to plants or root system. Set plants plumb and hold in position until sufficient soil has been firmly placed around the roots or ball. Set plants so that the root crown is 1" higher than the surrounding grade. Plant ground cover plants after the mulch is in place. Avoid contaminating the mulch with the planting soil.

B. Backfill balled and burlapped and container-grown plants with the native soil removed from the planting hole to approximately half the depth of the ball and then tamp and water. It is desirable to use 100% percent native soil to backfill the hole, but do not use unsuitable fill containing clay, rock or other unsuitable material. For balled and burlapped plants, carefully fold back the top half of the burlap and remove tying materials. Any wire caging or similar material, must be completely removed. Where plastic wrap or treated burlap is used in lieu of burlap, completely remove these materials before backfilling. Tamp and water remainder of backfill native soil; then form earth saucers or water basins around isolated plants with topsoil.
C. Plant bare-root stock arranging the roots in a natural position. Form a hill or mound in the center of the planting hole to allow the plant to sit at the proper depth. The roots are then spread out, over, and down the “hill” in a natural position. The “hill” should be firm to avoid settlement of the entire plant. Remove damaged roots with a clean cut. Carefully work native soil in among the roots. Tamp and water the remainder of native soil; then form earth saucers or water basins around isolated plants with topsoil.

3.4 STAKING AND GUYING

A. Stake and guy plants as shown on the drawings and as specified.
B. Drive stakes vertically into the ground to a depth of 2-1/2 to 3 feet in such a manner as not to injure the ball or roots, unless otherwise shown on the drawings.
C. Remove stakes and guy straps after one year.

3.5 EDGING PLANT BEDS

A. Uniformly edge beds using a sharp tool to provide a clear cut division line between the planted area and the adjacent turfgrass. Do not use any type of manufactured edging material. The properly mowed and maintained turfgrass will serve as edging for all landscape beds.

3.6 MULCHING PLANTS

A. Mulch within 48 hours after planting and apply a preemergence granular ornamental herbicide containing 2.0% trifluralin and 0.5% isoxaben. Apply at 200 lb per acre prior to both early spring and early fall weed seed germination. Do not mulch in ground cover areas that shall have organic material placed before planting.
B. Placing Inert Material: Spread a stone mulch to a uniform minimum thickness of 3 inches.
C. Keep mulch out of the crowns of shrubs and off buildings, sidewalks, light standards, and other structures.

3.7 PRUNING

A. Prune new plant material and indicated existing plant material in the following manner: Remove dead, broken and crossing branches. Make cuts with sharp instruments as close as possible to the branch collar. Do not make flush cuts. Do not make "Headback" cuts at right angles to line of growth. Do not pole trees or remove the leader. Remove trimmings from the site. Do not use any type of wound dressing on pruning cuts.
B. Existing trees to be pruned are shown on the drawings. Perform tree pruning and cavity work by a licensed arborist an arborist in accordance with ANSI Z 133.1. Remove dead wood 1/2 inch or more in diameter, branches interfering with or hindering the healthy growth of the trees, and diseased branches with a clean cut made flush with the branch collar. Cut back or remove branches as necessary to give the trees proper shape and balance. In removing large limbs, make the initial cut on the underside at a safe distance from the trunk or lateral, to prevent ripping of bark. Ensure branches and trimmings do not endanger traffic or cause damage to property during removal. Section large branches or limbs that cannot be removed in one piece

without endangering traffic or property. Lower sections by ropes. Repair any damage resulting from the Contractor's negligence during pruning. Workmen are not permitted to climb trees with climbing spurs. To promote proper healing, cut off flush with the branch collar stubs or limbs that have resulted from improper cuts or broken as a result of former pruning. Remove girdling roots.

3.8 FERTILIZATION OF EXISTING TREES

A. Apply fertilizer to existing trees shown on the drawings at the rate of 2 pounds per inch caliper. Apply in 4 inch to 8 inch deep holes 1-1/2 to 2 inches in diameter, made by an earth auger, distributed evenly at not more than 2 feet on center throughout the outer half of the branch spread zone of each tree. Fertilize to within 4 inches of the surrounding grade. Use topsoil to bring the surface up to the surrounding grade. When using fertilizer in packet, tablet, or wedge form, apply in accordance with manufacturer's recommendations.

3.9 TILLAGE FOR TURFGRASS AREAS

A. Thoroughly till compacted and/or consolidated soil to a depth of at least 6 inches by scarifying, disking, harrowing, or other approved methods. This is particularly important in areas where heavy equipment has been used. Remove all debris and stones larger than one inch remaining on the surface after tillage in preparation for finish grading. To minimize erosion, do not till areas of 3:1 slope ratio or greater. Scarify these areas to a two inch depth and remove debris and stones.

3.10 APPLICATION OF FERTILIZER AND LIME FOR TURFGRASS AREAS

A. Apply limestone and muriate of potash, and work into soil by spading, plowing, or rototilling.
B. Apply fertilizer and rake into soil immediately prior to seeding.
C. Three to four weeks after germination apply nitrogen.

3.11 MECHANICAL SEEDING

A. Broadcast seed by approved application equipment at the rate as outlined on the Plans. All turfgrass seed shall be planted prior to the application of any mulch material. The seed shall be uniformly distributed in a minimum of 2 directions at right angles to each other. Drag the seeded area to inter-mingle the seed and surface soil by means of spike-tooth harrow, cultipacker, or other approved device.
B. Immediately after dragging, firm the entire area with a roller not exceeding 150 pounds per foot of roller width.
C. Immediately after preparing the seeded area, evenly spread an organic mulch of straw by hand or by approved mechanical blowers at the rate of 2 tons per acre. Application shall allow some sunlight to penetrate and air to circulate but also reduce soil and seed erosion and conserve soil moisture. Anchor mulch by a mulch tiller, asphalt emulsion, twine, or netting. When asphalt emulsion is used, apply either simultaneously or in a separate application. Take precautionary measures to prevent asphalt materials from marking or defacing structures, pavements, utilities, or plantings.
D. Where a compost blanket is placed within a stormwater management facility, the appropriate seed mix shall be mixed into the compost prior to it being pneumatically blown into place.

3.12 HYDRO-MULCHING

A. When hydro-mulching, mix the slow release starter fertilizer, approved wood cellulose mulch material in the required amount of water to produce a homogenous slurry and then uniformly apply slurry under pressure to deliver the recommended quantity of fertilizer per 1000 sq.ft.

3.13 SODDING

A. Accomplish sodding in accordance with the ASPA Guideline Specifications for sodding. Lay sod at right angles to slope or the flow of water. On slope areas, start at the bottom of the slope.
B. After completing the sodding operation, blend the edges of the sodded area smoothly into the surrounding area. All sod should be rolled with a light- weight roller after being laid to eliminate air spaces between the sod and the firmed soil.

3.14 WATERING

A. Apply water to the turfgrass areas immediately following installation at a rate sufficient to ensure thorough wetting of the soil to a depth of at least 2 inches. Supervise watering operation to prevent run-off. Supply all pumps, hoses, pipelines, and sprinkling equipment. Repair all areas damaged by water operations. Keep soil surface constantly moist, not wet, until turfgrass plants are well established.
B. Contractor shall deep water all trees twice each week during the Plant Establishment Period, providing water penetration throughout the root zone to the full depth of the planting pits, as verified in the field by the Owner's Representative. Watering shall cease at the first hard frost in the fall and shall resume upon ground thaw in the spring.

3.15 PROTECTION OF TURFGRASS AREAS

A. Immediately after installation of the turfgrass areas, protect against traffic or other use by erecting barricades, as required, and placing approved signs at appropriate intervals until final acceptance.

3.16 EROSION CONTROL MATERIAL

A. See Section 31 25 00.

3.17 RESTORATION AND CLEAN-UP

A. Where existing or new turfgrass areas have been damaged or scarred during planting and construction operations, restore disturbed area to their original condition. Keep at least one paved pedestrian access route and one paved vehicular access route to each building clean at all times. In areas where planting and turfgrass work have been completed, clear the area of all debris, spoil piles, and containers. Clear all other paved areas when work in adjacent areas are completed. Remove all debris, rubbish and excess material from the station.

END OF SECTION

SECTION 331417

WATER SERVICE PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Furnish and install polyvinyl chloride pipe and tubing, fittings, and appurtenances as shown on the Plans and described herein.

B. All water mains, fittings, taps, valves, yard hydrants and fire hydrants shall be supplied, installed, disinfected, and tested in accordance with the requirements of Artesian Water Company and the Delaware Department of Health.

C. Furnish and install polyethylene water tubing for connections under three-inches in diameter.

D. Coordinate with the Artesian Water Company for service connections and to determine the scope of services to be performed by the Artesian Water Company.

E. Related work specified elsewhere includes:

Section 312000: Earth Moving

1.2 STANDARDS

A. Artesian Water Company Standards and Specifications.

B. American Water Works Association

1. AWWA C900
2. AWWA C901
3. AWWA C907
4. AWWA C909

1.3 SUBMITTALS

A. All pipe and fittings shall be inspected and tested at the place of manufacture as required by the AWWA standards referenced in the specification. Provide the Engineer with two copies of certifications from each manufacturer stating the product was inspected as required, and that the test results comply with AWWA standards.

B. Submit manufacturers' product data for pipe, fittings, valves, hydrants, and gaskets.

C. All manufacturers shall validate other than by certification, the ductility of each length of pipe by an Underwriters Laboratory approved method.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Polyvinyl Chloride Pipe (6” diameter or larger)
1. Water mains shall conform to AWWA C909, Minimum Class 165.

2. P.V.C. services shall conform to ASTM-2241 for SDR 21, unless otherwise approved by the Water Company or Engineer.
3. Joints for P.V.C. Pipe: Integral-bell, push-on, rubber gasketed joints except where mechanical joints are necessary to change pipe material, where specified by the Plan or by Artesian Water Company.

B. Polyvinyl Chloride Pipe (4” diameter)
1. Water mains shall conform to AWWA C900, Minimum Class 150.
2. P.V.C. services shall conform to ASTM-2241 for SDR 21, unless otherwise approved by the Water Company or Engineer.
3. Joints for P.V.C. Pipe: Integral-bell, push-on, rubber gasketed joints except where mechanical joints are necessary to change pipe material, where specified by the Plan or by Artesian Water Company.

C. High Density Polyethylene Tubing (2” diameter or smaller)
1. Water tubing shall be copper tube size and conform to AWWA C901, Minimum pressure rating 250 p.s.i.
2. P.V.C. services shall conform to ASTM D2737 for SDR 9 and ASTM D3350, unless otherwise approved by the Water Company or Engineer.

D. Pipe Fittings
1. Shall be polyvinyl chloride fittings conforming to AWWA C907, with minimum pressure class of 235 p.s.i.
2. Fittings shall have Integral-bell push-on joints except where mechanical joints are necessary to change pipe material, where specified by the Plan or by Artesian Water Company.

E. All water valves, valve boxes, yard hydrants, fire hydrants, corporation stops, curb stops, and curb boxes shall meet the requirements of the Artesian Water Company and the Delaware Department of Health.

PART 3 - EXECUTION

3.1 INSPECTION AND QUALITY OF PIPE

A. Before being lowered into the trench, each pipe shall be carefully inspected, and those not meeting the Specifications shall be rejected and either destroyed or removed from the work within ten (10) hours. No pipe shall be laid except in the presence of the Owner’s designated representative. The Owner’s designated representative may order the removal and relaying of any pipe not so laid.

B. The Contractor shall carefully examine all pipe and special castings before placing the same in the trench. Any pieces which are broken or show evidence of cracks or fractures shall be rejected by the Contractor. Such inspection shall carry with it the responsibility on the part of the Contractor for the removal at the Contractor’s own expense of all pipe, special castings, and appurtenances, incorporated in the work, and which under test are found to be cracked or otherwise defective.

3.2 INSTALLATION

A. Excavation and backfill for pipes shall conform to Specification Section 312000 – Earth Moving and shall be as shown on the Plans.

B. All piping shall be installed in a neat and workmanlike manner. All piping shall be installed to accurate lines and grades and shall be supported as shown, specified, or necessary. Where

temporary supports are used, they shall be sufficiently rigid to prevent shifting or distortion of the pipe. Suitable provision shall be made for expansion where necessary.

C. No defective pipe or fitting shall be laid or placed in the piping, and any piece discovered to be defective after having been laid shall be removed and replaced by a sound and satisfactory piece by the Contractor at the Contractor's own expense.

D. Every pipe and fitting shall be cleared of all dirt and other debris before being installed and shall be kept clean until accepted in the completed work.

E. No pipes shall be laid in fill or other unsuitable material, in a wet trench, or in same trench with another pipe or other utility unless so noted on the drawings. A minimum eighteen (18") inch clearance shall be maintained between the outside surface of pipe and outside surface of other existing pipes and structures. When this clearance cannot be maintained, contact the Engineer for instructions prior to proceeding with the pipe installation.

F. No direct contact between pipes and structures at crossings will be permitted. Pipes in place shall not be worked over or walked on until covered by backfill well tamped in place to a depth of twelve inches over the pipe.

G. Minimum cover over water mains shall be three and one half (3-½) feet.

H. The interior of all pipes shall be thoroughly cleaned of all foreign material before being lowered into trench. Pipes shall be kept clean during laying operations by means of plugs or other approved methods.

I. Gas, storm sewer, and sanitary sewer lines shall have right-of-way and water mains shall be installed to avoid the same.

J. If conflicts occur between proposed water lines and other utilities, the water lines shall be dropped below the conflicting utility to attain the proper clearance.

K. Brace all plugs as required to prevent leakage or blowout during testing.

L. All newly placed pipes shall be pressure tested, sterilized, and cleaned in accordance with the requirements of the Artesian Water Company, the Delaware Department of Health, and NFPA Standards and Specifications.

3.3 PIPING SUPPORTS

A. The Contractor shall furnish and install all supports necessary to hold the piping and appurtenances in a firm, substantial manner at the lines and grades indicated on the drawings or specified. Where required, bends, tees, and other fittings buried in the ground shall be backed up with concrete placed against undisturbed earth where firm support can be obtained. If the soil does not provide firm support, then suitable bridle rods, clamps, and accessories to brace the fitting properly shall be provided. Such bridle rods, etc., shall be coated thoroughly with an approved bituminous paint after assembly, or, if necessary, before assembly. This work shall include bracing plugs to prevent leakage or blowout during testing.

3.4 HANDLING AND CUTTING PIPE

A. Handle and lay pipe and fittings to avoid damage to the pipe, scratching or marring machined surfaces, and abrasion of the coating or lining. Pipe cuts shall be made using an abrasive wheel, rotary wheel cutter, guillotine pipe saw, milling wheel saw, or other method approved by the Engineer. Grind cut ends and rough edges smooth. For push-on connections, bevel cut all ends.

3.5 ASSEMBLING PIPE

A. Clean ring groove and bell socket prior to inserting rubber gasket seal. Properly seat gasket; make sure it faces proper direction.

B. Clean bell and spigot ends of pipe. Lubricate spigot end of pipe and rubber gasket.

C. Hold pipe securely and in proper alignment when joining.

D. Join pipe so that reference mark on spigot end, if provided by manufacturer, is flush with end of bell.

E. Join pipe in strict accordance with manufacturer's printed installation procedures.

3.6 PROTECTION

A. Protect all finished work. Joints once made and disturbed shall be subjected to immediate rejection. It shall therefore be the duty of the Contractor to avoid the slightest movement in completed work, while in the act of laying the pipe, in backfilling, or in the passage of workmen up and down the trench. At all times during which pipe is not being laid, the end of the pipe shall be sealed with a tight fitting plug. In no case will the drainage of trench water through a completed pipe be permitted.

B. All curves, bends, tees, hydrants and ends of pipe shall be securely blocked with socket clamps or yokes to prevent movement. At the end of a line or turn, where provision has been made for future extension or connections, fittings shall be furnished with lugs and anchored by means of socket clamps or yokes.

3.7 ADAPTORS

A. When it is necessary to join pipes of different types the Contractor shall furnish and install the necessary adaptors. Adaptors shall have ends conforming to the above Specifications for the appropriate type of joint to receive the adjoining pipe. When adaptors join two classes of pipe, the adaptors may be the lighter class.

3.8 CLEANING AND TESTING

A. All waterlines shall be fully cleaned, disinfected, and leak/pressure tested in accordance with the Artesian Water Company and the Delaware Department of Health standards and requirements, or the NFPA standards in the case of fire system lines, before being accepted by the Owner.

END OF SECTION

SECTION 333100

SANITARY SEWERAGE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Furnish and install polyvinyl chloride (PVC) gravity sewer and appurtenances as shown on the Plans and described herein.

B. Furnish and install sanitary manholes and structures, and connect proposed pipes to manholes and structures where shown on the Plans or as directed by the Engineer.

C. Coordinate with the New Castle County Department of Special Services to determine the scope of services and required inspections performed by New Castle County.

1.2 STANDARDS

A. New Castle County Department of Special Services standards and details.

B. American Society for Testing and Materials (ASTM)

1. ASTM D-3034: Polyvinyl Chloride (PVC) Sewer Pipe and Fittings.
2. ASTM D-3212-76: Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
3. ASTM 1785: Schedule 40 Polyvinyl Chloride (PVC) pipe.
4. ASTM C-270: Mortar for Unit Masonry.

1.3 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Storage and Materials

1. Store materials to prevent physical damage.
2. Store pipe and fittings off ground to prevent dirt and debris from entering.
3. Store flexible gasket materials and joint primer or adhesive compounds in cool dry place. Keep rubber gaskets clean, away from oil, grease, excessive heat, and out of direct sunlight.

B. Handling of Materials

1. Protect materials during transportation and installation to avoid physical damage.
2. Do not install out-of-round pipe.
3. Unload pipe to prevent abrasion.
4. Do not drag or push pipe while handling or distributing on project site.

1.3 SUBMITTALS

A. All pipe and fittings shall be inspected and tested at the place of manufacture as required by the ASTM standards referenced in the specification. Provide the Engineer with two copies of certifications from each manufacturer stating the product was inspected as required, and that the test results comply with ASTM standards.

B. Submit manufacturers' product data for pipe, fittings, and gaskets.

C. All manufacturers shall validate other than by certification, the ductility of each length of pipe by an Underwriters Laboratory approved method.

PART 2 - PRODUCTS

2.1 MATERIALS

A. P.V.C. Pipe and Fittings

1. ASTM D-3034, SDR 26.
2. ASTM 1785, Schedule 40 for building sanitary laterals
3. Joint material: Elastomeric ring rubber gasket, ASTM D-3212.
4. Joint material Primer/Adhesive: As provided or specified by pipe manufacturer.

B. All manholes and structures shall be precast and shall conform to New Castle County Department of Special Services standards and details. Precast manholes shall conform with Section 602 of the Standard Specifications, except where noted on the Plan.

C. Integrally-cast rubber gaskets shall be used where pipes join structures. Gaskets shall be as manufactured by A-Lok, Newman Sanitary Gasket Company, or approved equal, and shall be acceptable to the New Castle County Department of Special Services.

D. Manhole steps shall be as required by the New Castle County Department of Special Services

PART 3 - EXECUTION

3.1 MATERIAL INSPECTION

A. The following information shall be clearly marked on each pipe section of P.V.C. pipe:

1. Pipe type and SDR number.
2. Nominal pipe size.
3. The PVC cell classification.
4. Name or trademark of manufacturer.
5. The ASTM Specification designation.

B. P.V.C. Fittings shall have the following markings:

1. The ASTM Specification designation.
2. Manufacturer's name or trademark.
3. Nominal size.
4. The material designation.

C. The Contractor shall carefully examine all pipe and special castings before placing the same in the trench. Any pieces which are broken or show evidence of cracks or fractures shall be rejected by the Contractor. Such inspection shall carry with it the responsibility on the part of the Contractor for the removal at the Contractor’s own expense of all pipe, special castings, and appurtenances, incorporated in the work, and which under test are found to be cracked or otherwise defective.

D. Inspect manholes and structures for defects prior to placement. Precast manholes shall be free from visible cracks, holes, foreign inclusions or other injurious defects

E. Assure that all materials are of the type specified and are not defective. Unmarked pipe or pipe and materials not meeting Specifications requirements shall be removed from the site as directed by the Engineer.

3.2 PIPE INSTALLATION

A. Fine grade trench bottom so that pipe is supported for its full length.

B. Install piping beginning at the low point of the system, true to grades and alignment indicated on the Plans. Place the bell ends of the pipe facing upstream.

C. Do not lay pipe on unsuitable material, in wet trenches, or in same trench with another pipe or utility.

D. General Procedure for Joining Pipe

1. Do not use excavating equipment to force pipe sections together.
2. Hold pipe securely and in proper alignment when joining.
3. Do not disturb previously made joints. Check completed piping to assure joints are intact. Insure placement of backfill over pipe is accomplished without disturbing pipe position.
4. Do not allow earth, stones, or other debris to enter pipe or fittings.
5. Method of installing joint materials and joining piping shall be in strict accordance with manufacturer's printed instructions.

3.3 BACKFILL AND COMPACTION

A. Bedding and Initial Backfill

1. Bedding and initial backfill shall be in accordance with New Castle County Department of Special Services Standards.
2. Install initial backfill material as shown on the Plan details for the type of pipe being used.
3. When required, material shall be placed under the pipe haunch to provide adequate side support. Material shall be installed for entire trench width and shall be tamped and rodded to insure full contact with pipe at haunch up to the spring line.
4. Little or no tamping of the initial backfill directly over the pipe shall be done.

B. Final Backfill

1. Final backfill shall be in accordance with Specification Section 312000 – Earth Moving.

3.4 TESTING

A. Deflection Testing - P.V.C. Sanitary Sewer Pipe

1. For pipe conforming to the requirements of ASTM D-3034, the maximum allowable pipe deflection (reduction in vertical inside diameter) shall be 7%.
2. For pipe conforming to the requirements of ASTM D-2241, the maximum allowable pipe deflection (reduction in vertical inside diameter) shall be 5%.
3. Deflection tests shall be successfully performed on the complete installation by means of one of the following methods prior to the acceptance of construction.

   a. "Go-No-Go" mandrel properly sized.
   b. Calibrated television.

B. Lamping

1. Lamping shall be in accordance with the requirements of the New Castle County Department of Special Services Sewer lines shall meet the following standards to pass the lamping inspection:

    a. Barrel of pipe shall have no vertical deflection (not to be confused with the deflection test), and at least seventy-five percent of barrel shall be visible in the horizontal direction.
    b. Pipe not meeting this Specification shall be re-laid and re-lamped until compliance is achieved at no additional cost to the Owner.

C. Low Pressure Air Test

1. All gravity sanitary sewer lines shall be air tested in accordance with the requirements of the City of Wilmington Department of Public Works.
2. The drop in pressure during the prescribed test time shall not exceed 0.5 psi, from 3.5 to 3.0 psi testing pressure. A drop in pressure below 3.0 psi shall indicate a failure in the test.

END OF SECTION

SECTION 33400

STORMWATER UTILITIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Furnish and install polyvinyl chloride (PVC) storm pipe and appurtenances as shown on the Plans and described herein.

B. Furnish and install high density polyethylene (PE) gravity storm sewer pipe and appurtenances as shown on the Plans and described herein.

C. Furnish and install catch basins, manholes, lawn basins, and yard drains, and connect existing pipes to manholes or catch basins, and connect proposed pipes to existing manholes or catch basins where shown on the Plans or as directed by the Engineer.

D. Adjust manhole and catch basin tops where shown on the Plans.

1.2 STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM D-3034: Polyvinyl Chloride (PVC) Sewer Pipe and Fittings.
2. ASTM D-3212-76: Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
3. ASTM 1785: Schedule 40 Polyvinyl Chloride (PVC) pipe.
4. ASTM C-270: Mortar for Unit Masonry.
5. ASTM F-477: Elastomeric Seals for Joining Plastic Pipe
6. ASTM D-1784: Rigid Polyvinyl Chloride and Chlorinated Polyvinyl Chloride Compounds

B. Delaware Department of Transportation Standard Specifications for Road and Bridge Construction, dated August 2016, hereinafter referred to as the “Standard Specifications”:

1. Section 601: Pipe Culverts
2. Section 602: Drainage Structures
3. Section 1022: Portland Cement Concrete

1.3 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Storage and Materials

1. Store materials to prevent physical damage.
2. Store pipe and fittings off ground to prevent dirt and debris from entering.
3. Store flexible gasket materials and joint primer or adhesive compounds in cool dry place. Keep rubber gaskets clean, away from oil, grease, excessive heat, and out of direct sunlight.

B. Handling of Materials

1. Protect materials during transportation and installation to avoid physical damage.
2. Do not install out-of-round pipe.
3. Unload pipe to prevent abrasion.
4. Do not drag or push pipe while handling or distributing on project site.

PART 2 - PRODUCTS

2.1 MATERIALS

A. P.V.C. Pipe and Fittings

1. ASTM D-3034, SDR 26.
2. ASTM 1785, Schedule 40 for building rainwater conductors.
3. ASTM F-477, Pipe Tapping Tee Seal
3. Joint material: Elastomeric ring rubber gasket, ASTM D-3212.
4. Joint material Primer/Adhesive: As provided or specified by pipe manufacturer.

B. High Density Polyethylene Pipe and Fittings.

1. All polyethylene pipe 12-inches or larger in diameter shall have a corrugated outer wall and an integrally formed smooth interior, and shall meet AASHTO M294 and DelDOT Specifications Section 601 for Type “S” high density polyethylene pipe.
2. Pipes, couplings, and fittings shall be meet the requirements of AASHTO M294, modified as follows: Minimum pipe stiffness shall be 35 psi at 5% deflection and 30 psi at 10% deflection, when tested in accordance with ASTM D-2412.
3. Pipe joints shall be soil-tight or water-tight.
4. Pipe shall be “N-12” as manufactured by Advanced Drainage Systems, Inc. (ADS), “Sure-Lok”, as manufactured by Hancor, or approved equal.
5. Corrugated polyethylene pipe smaller than 12 inches in diameter shall have a single corrugated wall with annular interior and exterior corrugations. Pipe and fittings shall meet the requirements of AASHTO M252. Pipe joints shall be by cleated bell, split, internal and snap couplers, and shall be soil tight. Pipe shall be as manufactured by Advanced Drainage Systems, Hancor, or approved equal.

C. Precast or cast-in-place catch basins and manholes shall be Portland Cement Concrete (p.c.c.) and shall conform to Section 602 of the Standard Specifications. Precast manholes shall conform with ASTM C-478, except where noted on the Plan.

D. PVC catch basins and manholes shall be of pipe stock conforming to ASTM D-1784 cell class 12454 as indicated on the Plans and manufactured by Nyloplast, Timewell Drainage Products, Springfield Plastics, Inc or approved equal.

E. Pipe tapping tees shall be as manufactured by Inserta Fittings Co., Fernco Inc., or approved Equal.

PART 3 - EXECUTION

3.1 MATERIAL INSPECTION

A. The following information shall be clearly marked on each pipe section of P.V.C. pipe:

1. Pipe type and SDR number.
2. Nominal pipe size.
3. The PVC cell classification.
4. Name or trademark of manufacturer.
5. The ASTM Specification designation.

B. P.V.C. Fittings shall have the following markings:

1. The ASTM Specification designation.

2. Manufacturer's name or trademark.
3. Nominal size.
4. The material designation.

C. Polyethylene pipe shall be marked with the pipe class, date of manufacture, and the name or trademark of the manufacturer.

D. The Contractor shall carefully examine all pipe and special castings before placing the same in the trench. Any pieces which are broken or show evidence of cracks or fractures shall be rejected by the Contractor. Such inspection shall carry with it the responsibility on the part of the Contractor for the removal at the Contractor's own expense of all pipe, special castings, and appurtenances, incorporated in the work, and which under test are found to be cracked or otherwise defective.

E. Inspect catch basins and manholes for defects prior to placement. Structures shall be free from visible cracks, holes, foreign inclusions or other injurious defects

E. Assure that all materials are of the type specified and are not defective. Unmarked pipe or pipe and materials not meeting Specifications requirements shall be removed from the site as directed by the Engineer.

3.2 PIPE INSTALLATION

A. Fine grade trench bottom so that pipe is supported for its full length.

B. Install piping beginning at the low point of the system, true to grades and alignment indicated on the Plans. Place the bell ends of the pipe facing upstream.

C. Do not lay pipe on unsuitable material, in wet trenches, or in same trench with another pipe or utility.

D. General Procedure for Joining Pipe

1. Do not use excavating equipment to force pipe sections together.
2. Hold pipe securely and in proper alignment when joining.
3. Do not disturb previously made joints. Check completed piping to assure joints are intact. Insure placement of backfill over pipe is accomplished without disturbing pipe position.
4. Do not allow earth, stones, or other debris to enter pipe or fittings.
5. Method of installing joint materials and joining piping shall be in strict accordance with manufacturer's printed instructions.

E. Polyethylene pipe shall be installed in accordance with the manufacturer's written instructions or as directed by the Engineer. Joints for all polyethylene pipe greater than 12 inches in diameter shall be water-tight in accordance with ASTM D3212. Gasket shall meet the requirements of ASTM-F477.

F. Pipe tapping tees shall be installed per manufacturer's specifications and instructions.

3.3 BACKFILL AND COMPACTION

A. Bedding and Initial Backfill

1. Bedding and initial backfill shall be in accordance with the manufacturer's written instruction or, in absence of said instructions, in accordance with Section 312000 of the Specifications.
2. Install initial backfill material as shown on the Plan details for the type of pipe being used.

3. When required, material shall be placed under the pipe haunch to provide adequate side support. Material shall be installed for entire trench width and shall be tamped and rodded to insure full contact with pipe at haunch up to the spring line.
4. Little or no tamping of the initial backfill directly over the pipe shall be done.

B. Final Backfill

1. Final backfill shall be in accordance with Site Excavating, Filling, and Grading: Section 312000.

3.4 TESTING

A. Video Inspection
1. Storm lines shall meet the following standards to pass the video inspection.

a. Barrel of pipe shall have no vertical deflection (not to be confused with the deflection test), and at least seventy-five percent of barrel shall be visible in the horizontal direction.
b. Pipe not meeting this Specification shall be re-laid and re-lamped until compliance is achieved at no additional cost to the Owner.

3.5 CATCH BASINS AND MANHOLES

A. Catch basins and manholes shall be installed in accordance with Section 602 of the Standard Specifications.

B. Installation of rubber gaskets for precast and PVC catch basins and manholes shall be in accordance with the manufacturer's recommendations.

C. Precast and cast-in-place structure’s frames shall be well bedded in mortar, making a watertight joint. Cover and frame shall have a shop coat of asphaltic pitch and shall have a field coat of similar paint after the frame is set in final position.

D. PVC structures shall be cut to final height following final grading of surrounding area. Frames shall be seated on the PVC riser per manufacture’s recommendations.

END OF SECTION