

Jackson Co. Correctional Institute HVAC Renovations

Jackson County, Georgia Board of Commissioners
67 Athens St.
Jefferson, GA 30549

PROJECT MANUAL

Aug. 22, 2018



DRINKARD
ENGINEERING

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SECTION 01 00 00 - GENERAL REQUIREMENTS

PART 1 GENERAL

1.1 CONTRACTOR'S USE OF PREMISES

- A. Contractor shall limit use of premises to allow Owner occupancy and public use of premises. Coordinate all usage schedules and issues with Owner before mobilization.

1.2 SPECIFICATION CONVENTIONS

- A. These specifications are written in imperative mood and streamlined form. This imperative language is directed to the Contractor, unless specifically noted otherwise. The words "shall be" are included by inference where a colon (:) is used within sentences or phrases.

1.3 SCHEDULE OF VALUES

- A. Submit Schedule of Values on AIA Form G703 or EJCDC Form 1910-8-E within 15 days after date of Owner-Contractor Agreement.

1.4 APPLICATIONS FOR PAYMENT

- A. Submit each application on AIA Form G702 and G703 or EJCDC Form 1910-8-E. Payment period shall be monthly.
- B. Content and Format: Utilize Schedule of Values for listing items in Application for Payment.

1.5 CHANGE PROCEDURES

- A. Stipulated Sum/Price Change Order: Based on Contractor's request for Change Order as approved by Architect/Engineer. Change Order requests shall be submitted on AIA Form G701 or EJCDC Form 1910-8-B.

1.6 COORDINATION

- A. Coordinate scheduling, submittals, and Work of various sections of specifications to ensure efficient and orderly sequence of installation of interdependent construction elements.
- B. Verify utility requirement characteristics of operating equipment are compatible with building utilities before ordering any equipment.
- C. Coordinate space requirements and installation of mechanical and electrical work indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practical.
- D. In finished areas, conceal pipes, ducts, and wiring within construction.

1.7 FIELD ENGINEERING

- A. Establish elevations, lines, and levels and certify elevations and locations of the Work conform with Contract Documents.
- B. Verify field measurements are as indicated on shop drawings or as instructed by manufacturer.

1.8 PRECONSTRUCTION MEETINGS

- A. Architect/Engineer will schedule preconstruction meeting after Notice of Award for affected parties.
- B. When required in individual specification section, convene pre-installation meeting at Project site prior to commencing work of section.

1.9 PROGRESS MEETINGS

- A. Schedule and administer meetings throughout progress of the Work at maximum monthly intervals. Preside at meetings, record minutes, and distribute copies within two days to those affected by decisions made.

1.10 EQUIPMENT ELECTRICAL CHARACTERISTICS AND COMPONENTS

- A. Motors: NEMA MG1 Type; specific motor type is specified in individual specification sections.
- B. Wiring Terminations: Terminal lugs to match branch circuit conductor; size terminal lugs to NFPA 70.
- C. Cord and Plug: Minimum 6 foot cord and plug including grounding connector; cord of longer length is specified in individual sections.

1.11 CUTTING AND PATCHING

- A. Employ skilled and experienced installer to perform cutting and patching new Work; restore Work with new Products.
- B. Submit request in advance of cutting or altering structural or building enclosure elements.
- C. Execute cutting, fitting, and patching including excavation and fill, to complete Work, and to:
 - 1. Fit several parts together, to integrate with other Work.
 - 2. Uncover Work to install or correct ill-timed Work.
 - 3. Remove and replace defective and non-conforming Work.
 - 4. Remove samples of installed Work for testing.
 - 5. Provide openings in elements of Work for penetrations of mechanical and electrical Work.
- D. Cut masonry and concrete materials using masonry saw or core drill. Restore Work with new Products in accordance with requirements of Contract Documents.

- E. Fit Work tight to adjacent elements. Maintain integrity of wall, ceiling, or floor construction; completely seal voids.
- F. Fit Work tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
- G. Refinish surfaces to match adjacent finishes.

1.12 SUBMITTAL PROCEDURES

- A. Submittal form to identify Project, Contractor, subcontractor or supplier; and pertinent Contract Document references.
- B. All Submittals and Shop Drawings may be submitted electronically in PDF format to Engineer in a neat and orderly fashion.
- C. Apply Contractor's stamp, signed or initialed, certifying that review, verification of Products required, field dimensions, adjacent construction Work, and coordination of information is in accordance with requirements of the Work and Contract Documents.
- D. Identify variations from Contract Documents and Product or system limitations which may be detrimental to successful performance of completed Work.
- E. Clearly identify products being proposed/submitted on the Submittals with the appropriate tags used on plans. Clearly mark or highlight important design data.
- F. Revise and resubmit submittals as required; identify changes made since previous submittal.

1.13 CONSTRUCTION PROGRESS SCHEDULES

- A. Submit initial progress schedule within 15 days after date of Owner-Contractor Agreement for Architect/Engineer review.
- B. Submit revised schedules with each Application for Payment, identifying changes since previous version. Indicate estimated percentage of completion for each item of Work at each submission.

1.14 PROPOSED PRODUCTS LIST

- A. Within 15 days after date of Owner-Contractor Agreement, submit list of major Products proposed for use, with name of manufacturer, trade name, and model number of each product.

1.15 PRODUCT DATA

- A. Product Data:
 - 1. Submitted to Architect/Engineer for review for limited purpose of checking for conformance with information given and design concept expressed in Contract Documents.
 - 2. After review, provide copies and distribute in accordance with SUBMITTAL PROCEDURES article and for record documents purposes as specified.

- B. Submit number of copies which Contractor requires, plus one copy which will be retained by Architect/Engineer.
- C. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturer's standard data to provide information unique to this project.

1.16 SHOP DRAWINGS

- A. Shop Drawings:
 - 1. Submitted to Architect/Engineer for review for limited purpose of checking for conformance with information given and design concept expressed in Contract Documents.
 - 2. After review, provide copies and distribute in accordance with SUBMITTAL PROCEDURES article and for record documents purposes as specified.
- B. When required by individual specification sections, provide shop drawings signed and sealed by professional engineer responsible for designing components shown on shop drawings.
 - 1. Include signed and sealed calculations to support design.
 - 2. Submit drawings and calculations in form suitable for submission to and approval by authorities having jurisdiction.
 - 3. Make revisions and provide additional information when required by authorities having jurisdiction.
- C. Submit in form of one electronic or hard copy to be retained by Architect/Engineer.

1.17 MANUFACTURER'S INSTRUCTIONS

- A. When specified in individual specification sections, submit manufacturer printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, in quantities specified for Product Data.

1.18 MANUFACTURER'S CERTIFICATES

- A. When specified in individual specification sections, submit certifications by manufacturer to Architect/Engineer, in quantities specified for Product Data.
- B. Indicate material or Product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.

1.19 QUALITY CONTROL

- A. Monitor quality control over suppliers, manufacturers, Products, services, site conditions, and workmanship, to produce Work of specified quality.
- B. Comply with manufacturer's instructions.
- C. Comply with specified standards as minimum quality for the Work except when more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

1.20 TOLERANCES

- A. Monitor fabrication and installation tolerance control of installed Products over suppliers, manufacturers, Products, site conditions, and workmanship, to produce acceptable Work. Do not permit tolerances to accumulate.
- B. Comply fully with manufacturer's tolerances.

1.21 REFERENCES

- A. Conform to reference standards by date of issue current as of date of Contract Documents.
- B. When specified reference standard conflict with Contract Documents, request clarification from Architect/Engineer before proceeding.

1.22 LABELING

- A. Attach label from agency approved by authority having jurisdiction for products, assemblies, and systems required to be labeled by applicable code.
- B. Label Information: Include manufacturer's or fabricator's identification, approved agency identification, and the following information, as applicable, on each label.
 - 1. Model number, serial number, performance characteristics.

1.23 MANUFACTURER'S FIELD SERVICES AND REPORTS

- A. When specified in individual specification sections, require material or Product suppliers or manufacturers to furnish qualified staff personnel to observe site conditions and to initiate instructions when necessary. Report observations and site decisions or instructions that are supplemental or contrary to manufacturer's written instructions.

1.24 EXAMINATION

- A. Verify existing site conditions and substrate surfaces are acceptable for subsequent Work. Beginning new Work means acceptance of existing conditions.
- B. Verify utility services are available, of correct characteristics, and in correct location.

1.25 PREPARATION

- A. Clean substrate surfaces prior to applying next material or substance. Apply manufacturer required or recommended substrate primer, sealer, or conditioner prior to applying new material or substance in contact or bond.

1.26 TEMPORARY ELECTRICITY

- A. Provide temporary electricity and power outlets for construction operations, connections, branch wiring, distribution boxes, and flexible power cords as required. Do not disrupt Owner's need for continuous service.

1.27 TEMPORARY LIGHTING FOR CONSTRUCTION PURPOSES

- A. Provide and maintain temporary lighting for construction operations as needed. Provide branch wiring from power source to distribution boxes with lighting conductors, pigtails, and lamps as required.
- B. Permanent building lighting may be utilized during construction.

1.28 TEMPORARY HEATING AND COOLING

- A. Provide heating and cooling devices to heat and cool as needed to maintain specified conditions during construction operations.

1.29 PARKING

- A. Arrange for temporary parking areas to accommodate construction personnel.

1.30 PROGRESS CLEANING AND WASTE REMOVAL

- A. Collect and maintain areas free of waste materials, debris, and rubbish. Maintain site in clean and orderly condition.

1.31 FIRE PREVENTION FACILITIES

- A. Prohibit smoking within buildings under construction and demolition. Designate area on site where smoking is permitted. Provide approved ashtrays in designated smoking areas.
- B. Establish fire watch for cutting and welding and other hazardous operations capable of starting fires. Maintain fire watch before, during, and after hazardous operations until threat of fire does not exist.
- C. Portable Fire Extinguishers: NFPA 10; 10 pound capacity, 4A-60B; C UL rating.
 - 1. Provide one fire extinguisher at each stair on each floor of buildings under construction and demolition.
 - 2. Provide minimum one fire extinguisher in every construction trailer and storage shed.

1.32 BARRIERS AND FENCING

- A. Provide barriers or fencing to prevent unauthorized entry to construction areas and to protect existing facilities and adjacent properties from damage.

1.33 PROTECTION OF INSTALLED WORK

- A. Protect installed Work and provide special protection where specified in individual specification sections.

1.34 WATER CONTROL

- A. Maintain excavations free of water. Provide, operate, and maintain pumping equipment as needed.

1.35 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

- A. Remove temporary utilities, equipment, facilities, materials, prior to Final Application for Payment review.
- B. Restore existing facilities used during construction to original condition. Restore permanent facilities used during construction to specified condition.

1.36 PRODUCTS

- A. Products: Means new material, machinery, components, equipment, fixtures, and systems forming the Work, but does not include machinery and equipment used for preparation, fabrication, conveying and erection of the Work. Products may also include existing materials or components specifically identified for reuse.
- B. Do not use materials and equipment removed from existing premises, except as specifically identified or allowed by the Contract Documents.
- C. Provide interchangeable components of same manufacture for components being replaced.

1.37 DELIVERY, HANDLING, STORAGE, AND PROTECTION

- A. Deliver, handle, store, and protect Products in accordance with manufacturer's instructions.

1.38 PRODUCT OPTIONS

- A. Products Specified by Reference Standards or by Description Only: Any Product meeting those standards or description.
- B. Products Specified by Naming One or More Manufacturers: Products of manufacturers named and meeting specifications, no options or substitutions allowed.
- C. Products Specified by Naming One or More Manufacturers with Provision for Substitutions: Submit request for substitution for manufacturers not named.

1.39 SUBSTITUTIONS

- A. Architect/Engineer will consider requests for Substitutions during the bidding period up to 5 days before the Bid Date. Limit each request to one proposed substitution.
- B. Document each request with complete data substantiating compliance of proposed Substitution with Contract Documents. Provide side-by-side comparison of proposed Substitution with specified equipment. Engineer reserves the right to accept or reject any substitution request for any reason.
- C. If a substitution request by Contractor is accepted by Engineer, Contractor bears all responsibility for any resulting changes required for the implementation of such substitution. These include, but are not limited to, electrical changes, structural changes, or any other changes required to implement the substitution. All costs required for such changes shall be borne entirely by the Contractor.

1.40 CLOSEOUT PROCEDURES

- A. Submit written certification Contract Documents have been reviewed, Work has been inspected, and Work is complete in accordance with Contract Documents and ready for Architect/Engineer's inspection.
- B. Submit final Application for Payment identifying total adjusted Contract Sum/Price, previous payments, and amount remaining due.

1.41 FINAL CLEANING

- A. Execute final cleaning prior to final inspection.
- B. Clean interior and exterior surfaces exposed to view. Vacuum carpeted and soft surfaces.
- C. Clean debris from site, roofs, gutters, downspouts, and drainage systems.
- D. Replace filters of operating equipment. Clean washable filters.
- E. Remove waste and surplus materials, rubbish, and construction facilities from site.

1.42 STARTING OF SYSTEMS

- A. Provide seven days notification prior to start-up of each item.
- B. Ensure each piece of equipment or system is ready for operation.
- C. Execute start-up under supervision of responsible persons in accordance with manufacturer's instructions.
- D. Submit written report stating equipment or system has been properly installed and is functioning correctly.

1.43 DEMONSTRATION AND INSTRUCTIONS

- A. Demonstrate operation and maintenance of Products to Owner's personnel prior to date of final review.
- B. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.
- C. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at agreed-upon times, at equipment location.

1.44 TESTING, ADJUSTING, AND BALANCING

- A. Adjust operating products and equipment to ensure smooth and unhindered operation.

1.45 PROTECTING INSTALLED CONSTRUCTION

- A. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.
- B. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.
- C. Prohibit traffic or storage upon waterproofed or roofed surfaces. When traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.
- D. Prohibit traffic from landscaped areas.

1.46 PROJECT RECORD DOCUMENTS

- A. Maintain on site one set of Contract Documents to be utilized for record documents.
- B. Record actual revisions to the Work. Record information concurrent with construction progress.
- C. Specifications: Legibly mark and record at each Product section description of actual Products installed.
- D. Record Documents and Shop Drawings: Legibly mark each item to record actual construction.
- E. Submit documents to Architect/Engineer with claim for final Application for Payment.

1.47 OPERATION AND MAINTENANCE DATA

- A. Submit prior to final inspection, bound in 8-1/2 x 11 inch text pages, three D side ring binders with durable plastic covers.
- B. Prepare binder cover with printed title "OPERATION AND MAINTENANCE INSTRUCTIONS" and title of project.
- C. Internally subdivide binder contents with permanent page dividers, logically organized, with tab titles legibly printed under reinforced laminated plastic tabs.
- D. Contents:
 - 1. Part 1: Directory, listing names, addresses, and telephone numbers of Architect/Engineer, Contractor, subcontractors, and major equipment suppliers.
 - 2. Part 2: Operation and maintenance instructions, arranged by system.
 - 3. Part 3: Project documents and certificates.

1.48 WARRANTIES

- A. Provide duplicate notarized copies.
- B. Execute and assemble transferable warranty documents from subcontractors, suppliers, and manufacturers.

- C. Submit prior to final Application for Payment.

END OF SECTION

SECTION 23 05 00 - MECHANICAL GENERAL

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

- A. Specification: This specification is intended to cover all portions of this building.
- B. Reference Codes: This installation shall comply with the following codes and regulations.
 - 1. 2012 International Mechanical Code with all Supplements and Amendments.
 - 2. NFPA No. 90A Installation of Air Conditioning and Ventilation Systems.
 - 3. 2012 International Plumbing Code with all Supplements and Amendments.
 - 4. 2012 International Fuel Gas Code with all Supplements and Amendments.
 - 5. NFPA 54, latest accepted edition, National Fuel Gas Code.
 - 6. NFPA 70, latest accepted edition, National Electric Code.
 - 7. 2012 Life Safety Code with all Supplements and Amendments.
 - 8. Georgia State Handicapped Accessibility Code, latest accepted edition.
 - 9. 2012 Georgia State Minimum Standard Fire Prevention Code.
 - 10. 2012 Georgia State Energy Code for Buildings, with all Supplements and Amendments.
- C. Reference Standards: This installation shall comply with the following standards.
 - 1. Manufacturers Standardization Society of the Valve and fittings Industry (1815 North Ft. Meyer Drive, Arlington, VA 22209). MSS-SP-58-2002, called MSS-SP-58. MSS-SP-69-2003, called MSS-SP-69.
 - 2. American Society of Heating and Ventilating and Air Conditioning Engineers Guide, Fundamentals, 2009 Edition.
 - 3. Sheet Metal and Air Conditioning Contractor National Association (SMACNA) HVAC Duct Construction Standards, Metal & Flexible, 2005 Edition. Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems. 1986 Edition. Seismic Restraint Manual Guidelines for Mechanical Systems, Second Edition.
 - 4. American Society of Sanitary Engineers (ASSE) Standard, Latest Edition.
 - 5. North American Insulation Manufacturers Association (NAIMA) Fibrous Glass Duct Construction Standards.

1.2 REGULATIONS

- A. Attention is called to the fact that all work shall be done in accordance with all applicable City, County and State regulations, which regulations shall be considered as minimum requirements, and shall not alter the arrangement and pipe sizes indicated on the plans, except where they conflict.

1.3 DRAWINGS

- A. The work is shown on the drawings.

1.4 PROTECTION OF PUBLIC

- A. If the contractor must operate any potentially dangerous devices before all specified safety valves controls and devices are installed, he shall notify the Architect in writing. He shall not

operate such devices under these conditions until arrangements for supervision by competent operators have been instituted and Architect's written approval has been issued.

1.5 EXCAVATION, SHORING AND BRACING

- A. Excavate and back-fill for the installation of all underground work.
- B. Provide all shoring and bracing to prevent cave-ins during the construction period.

1.6 SHOP DRAWINGS

- A. Shop drawings shall be submitted for but not limited to the following items:
 - 1. All Scheduled Equipment
 - 2. Ductwork & Accessories
 - 3. Hangers
 - 4. Piping & Accessories
 - 5. Supports
 - 6. Vibration Isolation
 - 7. Fixtures
 - 8. Roof Portals
 - 9. Control System
 - 10. Duct Systems
 - 11. Equipment Curbs
 - 12. Insulation
 - 13. Filters
 - 14. Access Panels
 - 15. Louvers
 - 16. Pipe Sizes
- B. Provide with the submittal package the proposed Test & Balance Company's credentials as described in Section 23 05 93. Include a letter from the Test & Balance company indicating that they have read Section 23 05 93 and will perform testing and balancing of the mechanical systems as described in that Section.
- C. Provide a complete list of all accessories and options (indicate factory or field installed) for all scheduled mechanical equipment, including air distribution devices. Provide manufacturer generated specifications and ratings sheets for each individual piece of air conditioning and heating equipment. Generic photocopies from manufacturers catalog will not be accepted.
- D. In addition to cut sheets, provide a summary sheet indicating exactly what pipe material joining methods, valves, etc. will be provided in the various piping systems.
- E. The Contractor shall produce 1/4" scale CAD-generated ductwork and piping shop drawing for every area of the building. Contractor shall coordinate all new mechanical systems with other Divisions, specifically including piping, lights, the building structure, and ceiling heights. It shall be the Contractor's responsibility to ensure that the mechanical work is coordinated with all other trades. The shop drawings submitted shall reflect this coordination in its entirety, including location of piping 2" and larger, all ductwork (except runouts to diffusers), and all equipment by dimensions to column lines. Bottom of duct and bottom of pipe dimensions shall be taken from finished floor, and shall be recorded on the shop drawings for review. Any interferences or conflicts not resolved during normal shop drawing coordination between

trades shall be specifically noted to the Architect for his instructions. Conflicts arising out of work installed (or ductwork already fabricated) without shop drawings or shop drawings that have not been completely coordinated, shall be the Contractor's responsibility and at his expense for any necessary changes.

- F. The Contract Drawings are diagrammatic and indicated generally the size and location of ductwork and equipment. While duct sizes shall not be decreased, it is recognized that job site conditions may require re-routing or re-sizing of ductwork, and the Contractor shall be responsible for this coordination. Ductwork that has to be re-sized and/or re-routed as a result of this coordination effort shall be the Contractor's responsibility and at his expense. Ductwork re-sized shall be equivalent to that shown on the drawings.
- G. Steel fabrication shop drawings shall be coordinated with all Division 15/23 equipment and roof openings. The resulting coordination shall be confirmed and verification shall be submitted with associated equipment and roof curbs.
- H. Division 15/23 shall coordinate with structural steel contractors to insure where ductwork is required to be routed within joist space that an alternate to x bracing is installed. Failure to coordinate shall subject the Contractor to full cost incurred to meet the design intact on the contract documents.

1.7 MOTORS, WIRING AND ELECTRICAL EQUIPMENT

- A. All motors required for this work shall be built in accordance with the latest standards of National Electrical Manufacturer's Association, and shall be especially designed for quiet operation. All motors shall be selected for operation within their nameplate amperage. Adjustable bases shall be provided with motors and equipment which have belt drives.
- B. All electrical materials shall comply with requirements of the National Electric Code. All contactors, starters, relays and panels used in this work, which are included in Underwriters Label Service, shall be new and bear the National Board of Fire Underwriters inspection label. Material not included in Underwriters Label service shall be new and conform to NEMA or other applicable industry standard.
- C. Division 16/26, ELECTRICAL, provides for the furnishing of conduit and wire from electrical source to electrical use, called "path of power," and for the installation of certain line voltage devices specified in Division 15/23 which lie in the "path of power," including but not limited to:
 - 1. Manual switches.
 - 2. Line voltage thermostats.
 - 3. Solid state speed controllers.
 - 4. Operators for operable dampers.
 - 5. Aquastats for domestic hot water circulating pumps.
 - 6. Alarms for Flow Switches and Valve Supervisor Switches.
- D. The "path of power" terminates at contactors or control panels of the following listed items of equipment. These control panels contain starters/contactors for the motors or heaters installed on or within the unit and are specified in Division 15/23. Any wiring past the point of termination described above is Division 15/23 work.
 - 1. Packaged Rooftop Units.
 - 2. Domestic Water Heaters.

3. Make-up Air Units.
 4. Condensing and/or Heat Pump Units.
 5. Fan Coil Units.
 6. Ductless Split Systems.
 7. Electric Heaters.
- E. Division 16/26, ELECTRICAL, provides for electrical power to any given item of equipment at the voltage and phase required by the primary use only. If the item of equipment contains devices such as fans, thermostats, motorized dampers or other controls which require other than primary voltage for their proper function, then transformers shall be furnished under Division 15/23 for that purpose.
- F. Voltage and phase for Division 15/23 equipment shall be as specified by Division 16/26. Division 15/23 Contractor shall submit a list of all mechanical equipment requiring electrical connections to the Contractor prior to release of any equipment, for coordination with the Division 16/26 contractor. A copy of this list that has been reviewed and approved by the General Contractor shall be submitted to the Architect with the submittal for mechanical equipment. Failure to include this list may result in the rejection of the entire mechanical equipment submittal.
- G. The control power source (point of connection for control power) for major equipment except those single phase fans which are thermostatically controlled and those items listed in C above, are provided at the combination starters.
- H. The automatic control of signal for STOP-START of major equipment is furnished and installed to and from combination starts as part of Division 15/23.
- I. All other conduit and wire, not in "path of power" described above is included in Division 15/23.
- J. If any Division's Contractor makes a change by submittal, by delivery, by wiring rearrangement or power requirements, which results in increased costs, the Contractor initiating the change shall bear all cost increases.
- K. All motors that are 1 HP and larger shall be high efficiency motors with nominal and minimum full load efficiencies equal to or greater than those specified by the State Energy Code. Specifications shall be submitted for each motor furnished.
- L. Starters or contractors shall be furnished in Division 15/23 for each motor.
1. Magnetic starters shall be NEMA standard sizes adequate for the load served, Size 00, 1, 2, 3, 4. Half sizes and/or quarter sizes are not acceptable.
 2. Overload relays shall be unit constructed, hand reset melting alloy type, and shall be provided for all ungrounded legs.
 3. Units shall have NEMA-1 enclosures, three thermal overloads in three-phase starts, HAND-OFF-AUTO switches as required by the "controls" specification section.
 4. All fractional HP single-phase motors shall have internal thermal overload protection except where starters are scheduled.
 5. All motor starters shall be of the same manufacturer and shall be General Electric Type CR-306, or equal by Square-D, Westinghouse, Allen-Bradley, Furnas, Siemens, or Cutler-Hammer subject to full compliance with all criteria.

- M. Where power wiring to Division 15/23 equipment is not within the equipment curb, roof curb and boots shall be provided under Division 16/26. The portal location shall be coordinated with Division 15/23 equipment power inlet requirements, and located not to block access for equipment servicing.

1.8 ACCESS PANELS

- A. Shall be provided to permit operation of concealed valves, dampers, or equipment. The following table lists types of Bilco access frames and doors. Panels of equivalent construction by Titus, Milcor, Hohmann, and Barnard or Zurn are acceptable.
- B. Wall:
- | | |
|--------------|---------|
| 1. Sheetrock | Style G |
| 2. Plaster | Style A |
| 3. Masonry | Style C |
- C. Ceiling:
- | | |
|---------------------|---------|
| 1. Sheetrock | Style G |
| 2. Plaster | Style A |
| 3. Concealed spline | Style D |
| 4. Lay-in tile | None |
- D. Fire Rated Wall or Ceiling Style F (U.L Listed)
- E. Sizes shall be: Small valves – 12” x 12”. Multiple valves and dampers – 24” x 24”
- F. Access panels shall be insulated for sound barrier equal to wall in which it is installed.
- G. Acoustical Tile: Coordinate with tile installed to provide a removal tile at access point. Install a colored thumb tack to mark the access panel of above ceiling equipment, control instrument, valves or relay.

1.9 WARRANTY

- A. The Contractor shall operate the air conditioning, heating and ventilating systems and plumbing systems for a period of one week to the satisfaction of the Architect. Thereafter, the Contractor shall guarantee and be responsible for all materials and workmanship (parts and labor) for a period of one (1) year following the date of acceptance by the Architect.
- B. The Contractor shall also provide maintenance for the one (1) year period by providing four (4) periodic inspections at approximately three-month intervals, which shall include the following.
1. Check all bearing, align and oil or grease.
 2. Check belt tensions and pulley adjustment and adjust as necessary.
 3. Check filters and advise Owner when change is necessary.
 4. Check refrigerant charges and oil levels and replenish as necessary.
 5. Check and re-calibrate controls as necessary.
- C. Any required maintenance for the above shall be performed and materials needed shall be furnished by the Contractor. Not included in the materials to be furnished by the Contractor

are fuel, electricity, water and filters. Provide the Owner with four (4) copies of the inspection reports indicating all items checked and adjustment or repairs performed.

- D. Water heaters shall be guaranteed for five years; parts and labor.
- E. All equipment compressors shall be guaranteed for five years; parts and labor.

1.10 CUTTING AND PATCHING

- A. The Contractor shall set sleeves for pipes, ducts and equipment accurately before the concrete walls and floors are poured.
- B. Should the contractor neglect to perform this preliminary work and should cutting and patching be required in order to install the piping, ductwork or equipment, then the expense of the cutting and restoring of surfaces to their original condition shall be borne by the Contractor.

1.11 BASIS OF DESIGN

- A. When brand, trade or manufacturer's names are used for basis of design, they are used in the interest of brevity to describe the style, type, size, quality or arrangement of articles of equipment and are not intended to limit competition. If articles of equipment by manufacturers other than basis of design are submitted for installation, the Architect/Engineer shall compare them with specified articles of equipment on basis of qualities mentioned. The size, weight and arrangement of other equipment shall be checked by the Contractor to ascertain that it can be installed, connected, operated, and serviced successfully, and that walking space and service space can be maintained without altering equipment space or enclosures or the work of other trades. Manufacturers not listed as "Acceptable Manufacturers" will not be considered.
- B. If any Division's Contractor makes a change by submittal, by delivery or by wiring rearrangement which results in increased costs, the Contractor initiating the change shall bear all cost increases.

1.12 AS-BUILT DRAWINGS

- A. Per the Georgia State energy Code, the Contractor shall produce and submit to the Architect, "As-Built" drawings, four (4) copies, as described below.
- B. As work progresses, neatly and clearly record on four (4) sets of mechanical plans (in red) all changes and deviations from the contract drawings in size, locations, etc., of all piping, ductwork terminal units and other equipment. Record (in red) final location of piping, ductwork, starts, valves, thermostats, etc., by dimensions to adjacent walls and floors. Make sufficient measurement to accurately locate all equipment. Locate underground lines by dimension from building walls.

1.13 OPERATION AND MAINTENANCE MANUALS

- A. Operation and Maintenance manuals (6 sets) shall be provided to the Owner or the Owners design nated representative. Manuals shall be in accordance with the Georgia State Energy Code for Buildings.

1. Manuals shall include as a minimum the following:
 - a. Final, corrected submittal data with equipment sizes and selected options for each piece of equipment, including Engineer's submittal review comments.
 - b. Current manufacturer's published operation and maintenance manuals for each piece of equipment.
 - c. Name, address and phone number of at least one LOCAL service agency.
 - d. HVAC controls system maintenance and calibration information including wiring diagrams, schematics, and control drawings.
 - e. Complete narrative of how each system is intended to operate, including suggested set-points.
 - f. Copy of the final Test & Balance report.
 - g. Copy of the final As-built drawings.
 - h. Controls certification letter.
 - i. Copy of Engineer's final punch list items, with each item checked off when completed or an explanation of why the item was not completed.

1.14 INTERFACES WITH OTHER WORK

- A. There are many interfaces between the work involved with Division 15/23 and the work involved with other Sections and Divisions, particularly with Division 16/26. Contractor shall be aware of the requirements of these other Sections or Divisions and his responsibilities at the interfaces.
- B. No mechanical equipment, piping, or ductwork shall be placed within 42" of switchboards and/or panel boards.
- C. No water piping (domestic, storm, sanitary, etc., except sprinkler piping when required) shall be located above electrical switchboards and/or panel boards. When sprinklers are required, shields must be provided over the panels.

1.15 EQUIPMENT IDENTIFICATION

- A. Equipment Identification:
 1. All mechanical equipment shall be labeled with Bakelite nameplates with 2" high white letters on a black background, securely affixed to equipment for outdoor or indoor service.
 2. Equipment Identification numbers shall be the same as those scheduled on the design drawings. Identification shall be located where it can be conveniently read, and shall be located in the same relative position on like equipment.
 3. In addition to the above ID tags, all scheduled equipment shall be provided with permanent factory installed engraved nameplate labels listing complete model and serial numbers, unit voltage, motor sizes, etc.
 4. Identify all disconnect switches that are not directly attached to the equipment that they serve, with identical ID tags as specified above for the equipment.

1.16 PIPE IDENTIFICATION

- A. All piping systems shall be identified.
 1. All piping systems within the building except as noted herein shall be identified with clear block letters and number stenciled on the outside surface of the pipe or insulation, indicating the system contents by abbreviated letters and direction of the flow.

2. This identification marking shall be applied to the pipe systems where pipe enters or leaves a wall or floor, and item of equipment such as pumps, fan coil units and tanks, and at tees. Identification shall be applied no less than 50 feet apart on horizontal pipe; and one identification per floor on vertical pipe.
3. Letters and numbers shall be high on pipe 2" and smaller.
4. Letters and numbers shall be 1" high on pipe 3" and larger.
5. Directional arrows shall be 4" long and "wide.
6. Letters and numbers shall be black on white pipe or insulation.
7. Letters and number shall be white on dark pipe or insulation.
8. Pipe identification symbols shall be the same as shown on the drawings.
9. Soil, vent and refrigerant piping shall not be identified.

1.17 PERMITS AND INSPECTIONS

- A. The Contractor shall secure and pay for all permits, fees, inspections, and utility connection costs.
- B. **BOILER TEST CERTIFICATES:** It shall be the Contractor's responsibility to have each boiler, large (greater than 120 gallon capacity) water heater, and pressure vessel inspected by a State of Georgia certified inspector upon installation. Each inspection report shall be submitted to the Georgia Department of Labor, Safety Engineering Section, 1700 Century Circle, Atlanta, Georgia 30345 to the attention of Direction of Engineering, PLUS a copy of each report transmitted to the Architect/Engineer. ONE additional copy of each report shall be included in EACH of the FOUR Close-Out Manuals.

1.18 EQUIPMENT & MATERIAL PROTECTION

- A. All equipment and material shall be kept clean and free of debris as construction progresses. Closures shall be provided over duct, piping and major equipment openings during storage, erection and prior to connection. Material finishes shall be protected by covers to prevent impingement of corrosive, abrasive and disfiguring foreign matter. Accidental finish damage shall be repaired equivalent to original finish.

1.19 TEST, BALANCE AND REPORT

- A. See Section 23 05 93.

1.20 PROHIBITED MATERIALS

- A. All products, materials or assemblies which contain asbestos or polychlorinated biphenyl (PCB) in any form or in any concentration whatsoever, are expressly forbidden from being used on this project.

1.21 SITE VISIT AND FAMILIARIZATION

- A. Contractors proposing to undertake work under this Division shall visit the site of the work and fully inform themselves of all conditions that effect the work or cost thereof, examine the drawings and specifications as related to the site conditions, and acquaint themselves with the utility companies from whom services will be supplied; verify locations of utility services and determine requirements for connections.

- B. Consideration will not be granted for any alleged misunderstanding of the amount of work to be performed. Tender of proposal shall convey full agreement to all items and conditions specified, indicated on the drawings, and/or required by nature of the site.
- C. Attention is called to the fact that this scope of work includes renovation to an existed facility and/or an addition to an existing building. When the work is finished, the mechanical systems shall be complete in every respect, and completely integrated with all affected mechanical and control systems.
- D. Existing mechanical systems in the existing facility shall not be interrupted without prior approval of the Owner or Architect.

END OF SECTION

SECTION 23 05 93 – TESTING, ADJUSTING, AND BALANCING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Testing adjusting, and balancing of air systems.
 - 2. Testing adjusting, and balancing of hydronic systems.
 - 3. Measurement of final operating condition of HVAC systems.

1.2 REFERENCES

- A. Associated Air Balance Council:
 - 1. AABC MN-1 - National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems.
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
 - 1. ASHRAE 111 - Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning and Refrigeration Systems.
- C. Natural Environmental Balancing Bureau:
 - 1. NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

1.3 SUBMITTALS

- A. Prior to commencing Work, submit proof of latest calibration date of each instrument.
- B. Test Reports: Indicate data on AABC MN-1, ASHRAE 111, or NEBB forms.
- C. Field Reports: Indicate deficiencies preventing proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
- D. Prior to commencing Work, submit report forms or outlines indicating adjusting, balancing, and equipment data required. Include detailed procedures, agenda, sample report forms and Copy of AABC or NEBB Certificate of Conformance Certification.
- E. Submit draft copies of report for review prior to final acceptance of Project.
- F. Furnish reports in 3 ring binder manuals, complete with table of contents page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: Furnish final copy of testing, adjusting, and balancing report inclusion in operating and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with AABC MN-1 National Standards for Field Measurement and Instrumentation, Total System Balance, ASHRAE 111, or NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.
- B. Prior to commencing Work, calibrate each instrument to be used.

1.6 QUALIFICATIONS

- A. Agency: Company specializing in testing, adjusting, and balancing of systems specified in this section with minimum five years documented experience certified by AABC and/or NEBB.
- B. Perform Work under supervision of AABC or NEBB Certified Test and Balance Supervisor.

PART 2 EXECUTION

2.1 EXAMINATION

- A. Verify systems are complete and operable before commencing work. Verify the following:
 1. Systems are started and operating in safe and normal condition.
 2. Temperature control systems are installed complete and operable.
 3. Proper thermal overload protection is in place for electrical equipment.
 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 5. Duct systems are clean of debris.
 6. Fans are rotating correctly.
 7. Fire and volume dampers are in place and open.
 8. Air coil fins are cleaned and combed.
 9. Access doors are closed and duct end caps are in place.
 10. Air outlets are installed and connected.
 11. Duct system leakage is minimized.
 12. Hydronic systems are flushed, filled, and vented.
 13. Pumps are rotating correctly.
 14. Proper strainer baskets are clean and in place or in normal position.
 15. Service and balancing valves are open.

2.2 PREPARATION

- A. Furnish instruments required for testing, adjusting, and balancing operations.

2.3 INSTALLATION TOLERANCES

- A. Air Handling Systems: Adjust to within plus or minus 10 percent of design.
- B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space.
- C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

2.4 ADJUSTING

- A. Verify recorded data represents actual measured or observed conditions.
- B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- C. After adjustment, take measurements to verify balance has not been disrupted. If disrupted, verify correcting adjustments have been made.
- D. Report defects and deficiencies noted during performance of services, preventing system balance.
- E. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

2.5 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to obtain required or design supply, return, and exhaust air quantities.
- B. Make air quantity measurements in main ducts by Pitot tube traverse of entire cross sectional area of duct.
- C. Measure air quantities at air inlets and outlets.
- D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts.
- E. Use volume control devices to regulate air quantities only to extent adjustments do not create objectionable air motion or sound levels. Effect volume control by using volume dampers located in ducts.
- F. Vary total system air quantities by adjustment of fan speeds. Provide sheave drive changes to vary fan speed. Vary branch air quantities by damper regulation.
- G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

- H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across fan. Make allowances for 50 percent loading of filters.
- I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- K. At modulating damper locations, take measurements and balance at extreme conditions. Balance variable volume systems at maximum airflow rate, full cooling, and at minimum airflow rate, full heating.
- L. Measure building static pressure and adjust supply, return, and exhaust air systems to obtain required relationship between each to maintain approximately 0.05 inches positive static pressure.
- M. Check multi-zone units for motorized damper leakage. Adjust air quantities with mixing dampers set first for cooling, then heating, then modulating.
- N. For variable air volume system powered units set volume controller to airflow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable-air-volume temperature control.
- O. On fan powered VAV boxes, adjust airflow switches for proper operation.

2.6 WATER SYSTEM PROCEDURE

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

2.7 SCHEDULES

- A. Equipment Requiring Testing, Adjusting, and Balancing:
 - 1. HVAC Pumps.
 - 2. Packaged Steel Fire Tube Boilers.
 - 3. Air Cooled Water Chillers.
 - 4. Unit Air Conditioners & Heaters.
 - 5. Air Coils.
 - 6. Air Handling Units.
 - 7. Fans.
 - 8. Air Filters.
 - 9. Air Terminal Units.
 - 10. Air Inlets and Outlets.

- B. Report Forms
 - 1. Title Page:
 - a. Name of Testing, Adjusting, and Balancing Agency
 - b. Address of Testing, Adjusting, and Balancing Agency
 - c. Telephone and facsimile numbers of Testing, Adjusting, and Balancing Agency
 - d. Project name
 - e. Project location
 - f. Project Architect
 - g. Project Engineer
 - h. Project Contractor
 - i. Project altitude
 - j. Report date
 - 2. Summary Comments:
 - a. Design versus final performance
 - b. Notable characteristics of system
 - c. Description of systems operation sequence
 - d. Summary of outdoor and exhaust flows to indicate building pressurization
 - e. Nomenclature used throughout report
 - f. Test conditions
 - 3. Instrument List:
 - a. Instrument
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Range
 - f. Calibration date
 - 4. Electric Motors:
 - a. Manufacturer
 - b. Model/Frame
 - c. HP/BHP and kW
 - d. Phase, voltage, amperage; nameplate, actual, no load
 - e. RPM

- f. Service factor
- g. Starter size, rating, heater elements
- h. Sheave Make/Size/Bore
- 5. V-Belt Drive:
 - a. Identification/location
 - b. Required driven RPM
 - c. Driven sheave, diameter and RPM
 - d. Belt, size and quantity
 - e. Motor sheave diameter and RPM
 - f. Center to center distance, maximum, minimum, and actual
- 6. Pump Data:
 - a. Identification/number
 - b. Manufacturer
 - c. Size/model
 - d. Impeller
 - e. Service
 - f. Design flow rate, pressure drop, BHP and kW
 - g. Actual flow rate, pressure drop, BHP and kW
 - h. Discharge pressure
 - i. Suction pressure
 - j. Total operating head pressure
 - k. Shut off, discharge and suction pressures
 - l. Shut off, total head pressure
- 7. Chillers:
 - a. Identification/number
 - b. Manufacturer
 - c. Capacity
 - d. Model number
 - e. Serial number
 - f. Evaporator entering water temperature, design and actual
 - g. Evaporator leaving water temperature, design and actual
 - h. Evaporator pressure drop, design and actual
 - i. Evaporator water flow rate, design and actual
 - j. Condenser entering water temperature, design and actual
 - k. Condenser pressure drop, design and actual
 - l. Condenser water flow rate, design and actual
- 8. Cooling Coil Data:
 - a. Identification/number
 - b. Location
 - c. Service
 - d. Manufacturer
 - e. Air flow, design and actual
 - f. Entering air DB temperature, design and actual
 - g. Entering air WB temperature, design and actual
 - h. Leaving air DB temperature, design and actual
 - i. Leaving air WB temperature, design and actual
 - j. Water flow, design and actual
 - k. Water pressure drop, design and actual

- l. Entering water temperature, design and actual
 - m. Leaving water temperature, design and actual
 - n. Saturated suction temperature, design and actual
 - o. Air pressure drop, design and actual
9. Heating Coil Data:
- a. Identification/number
 - b. Location
 - c. Service
 - d. Manufacturer
 - e. Air flow, design and actual
 - f. Water flow, design and actual
 - g. Water pressure drop, design and actual
 - h. Entering water temperature, design and actual
 - i. Leaving water temperature, design and actual
 - j. Entering air temperature, design and actual
 - k. Leaving air temperature, design and actual
 - l. Air pressure drop, design and actual
10. Unit Ventilator and Fan Coil Data:
- a. Manufacturer
 - b. Identification/number
 - c. Location
 - d. Model number
 - e. Size
 - f. Air flow, design and actual
 - g. Water flow, design and actual
 - h. Water pressure drop, design and actual
 - i. Entering water temperature, design and actual
 - j. Leaving water temperature, design and actual
 - k. Entering air temperature, design and actual
 - l. Leaving air temperature, design and actual
11. Air Moving Equipment:
- a. Location
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Arrangement/Class/Discharge
 - f. Air flow, specified and actual
 - g. Return air flow, specified and actual
 - h. Outside air flow, specified and actual
 - i. Total static pressure (total external), specified and actual
 - j. Inlet pressure
 - k. Discharge pressure
 - l. Sheave Make/Size/Bore
 - m. Number of Belts/Make/Size
 - n. Fan RPM
12. Return Air/Outside Air Data:
- a. Identification/location
 - b. Design air flow

- c. Actual air flow
 - d. Design return air flow
 - e. Actual return air flow
 - f. Design outside air flow
 - g. Actual outside air flow
 - h. Return air temperature
 - i. Outside air temperature
 - j. Required mixed air temperature
 - k. Actual mixed air temperature
 - l. Design outside/return air ratio
 - m. Actual outside/return air ratio
13. Exhaust Fan Data:
- a. Location
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Air flow, specified and actual
 - f. Total static pressure (total external), specified and actual
 - g. Inlet pressure
 - h. Discharge pressure
 - i. Sheave Make/Size/Bore
 - j. Number of Belts/Make/Size
 - k. Fan RPM
14. Duct Traverse:
- a. System zone/branch
 - b. Duct size
 - c. Area
 - d. Design velocity
 - e. Design air flow
 - f. Test velocity
 - g. Test air flow
 - h. Duct static pressure
 - i. Air temperature
 - j. Air correction factor
15. Terminal Unit Data:
- a. Manufacturer
 - b. Type, constant, variable, single, dual duct
 - c. Identification/number
 - d. Location
 - e. Model number
 - f. Size
 - g. Minimum static pressure
 - h. Minimum design air flow
 - i. Maximum design air flow
 - j. Maximum actual air flow
 - k. Inlet static pressure
16. Air Distribution Test Sheet:
- a. Air terminal number

- b. Room number/location
- c. Terminal type
- d. Terminal size
- e. Area factor
- f. Design velocity
- g. Design air flow
- h. Test (final) velocity
- i. Test (final) air flow
- j. Percent of design air flow

END OF SECTION

SECTION 23 07 00 - HVAC INSULATION

PART 1 GENERAL

1.1 GENERAL

- A. Section 23 05 00 applies.

PART 2 PRODUCTS

2.1 BASIS OF DESIGN

- A. Manufacturers shown below as Basis of Design
1. Acceptable Manufacturers for Glass Fiber and Mineral Fiber Insulation Products:
CertainTeed, Knauf, Johns Manville, Owens-Corning.
 2. Acceptable Manufacturers for Closed Cell Elastomeric Insulation Products:
Aeroflex Aerocell, Armacell Armaflex, Nomaco K-flex.

2.2 DUCT INSULATION

- A. Supply, Return, Exhaust, and Outdoor Ventilation Ducts
1. Duct liner: ASTM C1071, Type I, flexible, glass fiber duct liner with 100% coated air side. Minimum density 1.5 lb/ft³.
 2. Externally insulated: All sheet metal supply, return, and outdoor ventilation ducts shall be insulated on the outside with a Formaldehyde-free, flexible glass fiber blanket. Insulation shall have a minimum installed R-value of R-6 and have a Type 75 facing. Insulation shall be provided with a factory-applied facing with a composite UL HFC rating of 25/50. Basis of Design: Johns-Manville Microlite XG Formaldehyde-free Fiber Glass Duct Wrap.
 3. All supply, return, and outdoor ventilation air ducts shall be completely insulated on the outside.
 4. New exhaust ducts shall be insulated within 10 feet of exterior openings.
 5. Duct shown as internally lined shall be also externally insulated as needed to bring total R-value to required level.

2.3 PIPE INSULATION

- A. Hydronic Heating Water Piping
1. ASTM C547, molded glass fiber pipe insulation.
 2. Thermal Conductivity: 0.23 at 75 degrees F.
 3. Operating Temperature Range: 0 to 850 degrees F.
 4. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied reinforced foil kraft with self-sealing adhesive joints.
 5. Jacket Temperature Limit: minus 20 to 150 degrees F.
 6. Thickness: 1-1/2" for all pipes under 1-1/2" in size, 2" for larger pipes.
- B. Chilled Water Piping
1. ASTM C547, molded glass fiber pipe insulation.
 2. Thermal Conductivity: 0.23 at 75 degrees F.

3. Operating Temperature Range: 0 to 850 degrees F.
 4. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied reinforced foil kraft with self-sealing adhesive joints.
 5. Jacket Temperature Limit: minus 20 to 150 degrees F.
 6. Thickness: 1/2" for all pipes under 1-1/2" in size, 1" for larger pipes.
- C. Condensate Piping
1. ASTM C534, Type I, flexible, closed cell elastomeric insulation, tubular.
 2. Thermal Conductivity: 0.27 at 75 degrees F.
 3. Operating Temperature Range: Range: Minus 70 to 180 degrees F.
 4. Thickness: 1/2" thickness for all pipe sizes.

PART 3 EXECUTION

3.1 INSTALLATION – DUCT SYSTEMS

- A. Verify all surfaces are clean and dry before applying insulation.
- B. Butt joints of insulation together to obtain total coverage. Do not compress the insulation. Tape all joints.
- C. Mechanical fasteners: weld or adhesive applied pins shall be used to secure insulation to bottom of ducts 20" wide or wider. Install 18" on centers, both directions.
- D. Place holding washers over weld pins firmly, do not compress insulation, clip of excessive length of pin, cover with 4" length of tape.
- E. Where 2" flaps are provided, use adhesive to obtain full 2" coverage in lieu of tape.
- F. Repair breaks, holes, and perforations to full thickness flush with adjoining surface, with new sections if large, with tape on small areas so that 2" of tape or replacement foil-kraft project away from the imperfection.
- G. Insulation on round ducts may be wired in place with soft monel wire, 12" O.C., with joints taped and vapor sealed.
- H. Cover flexible equipment connections on air conditioning units with specified supply/return duct insulation. Lap connection 6" and secure 2" edge flap with adhesive.

3.2 INSTALLATION – PIPING SYSTEMS

- A. Verify piping has been tested before applying insulation materials. Verify surfaces are clean and dry, with foreign material removed. Piping Exposed to View in Finished Spaces: Locate insulation and cover seams in least visible locations.
- B. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Provide intumescent firestopping when continuing insulation through assembly. Finish at supports, protrusions, and interruptions.
- C. Piping Systems Conveying Fluids Below Ambient Temperature:
 1. Insulate entire piping system including fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.
 2. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
 3. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor retarder adhesive or PVC fitting covers.
- D. Inserts and Shields:

1. Piping 1-1/2 inches Diameter and Smaller: Install steel shield between pipe hanger and insulation.
 2. Piping 2 inches Diameter and Larger: Install insert between support shield and piping and under finish jacket.
 - a. Insert Configuration: Minimum 6 inches long, of thickness and contour matching adjoining insulation; may be factory fabricated.
 - b. Insert Material: Compression resistant insulating material suitable for planned temperature range and service.
 3. Piping Supported by Roller Type Pipe Hangers: Install galvanized steel shield between roller and inserts.
- E. Condensate Piping: Insulate entire piping system and components inside the building space to prevent condensation.
- F. Closed Cell Elastomeric Insulation:
1. Push insulation on to piping, miter joints at elbows.
 2. Seal seams and butt joints with manufacturer's recommended adhesive.
 3. When application requires multiple layers, apply with joints staggered.
 4. Insulate fittings and valves with insulation of like material and thickness as adjacent pipe.
- G. Refrigeration suction piping shall be insulated through pipe clamps and hangers, provide insulation shields when insulation passes through clamps and hangers.
- H. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces: Finish with PVC jacket and fitting covers. Labels on exterior covers should be oriented so as to be easily readable and shall have directional flow arrows.
- I. Buried Piping: Insulate only where insulation manufacturer recommends insulation product may be installed in trench, tunnel or direct buried. Install factory fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with 1 mil thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with polyester film.

END OF SECTION

SECTION 23 09 00 – HVAC AUTOMATIC CONTROLS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes control equipment and software.
- B. Work included: Furnish all labor, materials, equipment, and service necessary for a complete and operating Building HVAC Control System (BCS), utilizing Direct Digital Controls (DDC) as shown on the drawings and described herein. The BCS shall provide HVAC system control, lighting control, water heating control, energy management, alarming, monitoring, and reporting functions with operator interface as described on the drawings or elsewhere in this specification.
- C. Related Sections:
 - 1. Section 23 05 00 – Mechanical General

1.2 REFERENCES

- A. American National Standards Institute:
 - 1. ANSI MC85.1 - Terminology for Automatic Control.

1.3 SYSTEM DESCRIPTION

- A. System Narrative
 - 1. The system shall consist of application specific controllers mounted at each piece of equipment, connected via communications network to a Web-Server interface for local/remote access via a contractor-furnished laptop computer using Microsoft Internet Explorer. The application specific controllers shall provide all of the software functions described without the use of custom control language or a supervisory controller. Provide the temperature sensors where shown on the plans as “Thermostat” (T).
- B. General Requirements:
 - 1. Provide and install a dedicated, stand-alone automatic Building HVAC Control System (BCS) complete with all required software and hardware as described in the sections that follow.
 - 2. The BCS system shall provide stand-alone, independent control of all mechanical systems.
 - 3. The controls contractor shall assume complete single-source responsibility for the entire controls system. He shall certify that he has on staff, under his direct employ, certified factory trained technical personnel qualified to project manage, engineer, commission, and service all portions of the control system.
- C. Basic System Features:
The BCS system shall provide:
 - 1. Stand-alone independent control for all mechanical systems as described in the sections that follow.

2. Complete energy management software and firmware that resides and executes in networked field controllers. Operator workstation software shall not be utilized for energy management execution.
3. Alarm management capability for all mechanical equipment described in the sections that follow – including alarm occurrence, annunciation, e-mail to remote users, acknowledgement, problem diagnostics, and reporting functions.
4. Complete password protected system monitoring through a local networked operator workstation, or through remote operator workstations. Remote workstations shall utilize Internet or Ethernet communications links, as required.
5. Standard and customized manual or automatic reports of trends, runtimes, consumables, alarms, and system operator activities – including report archiving as described in the sections that follow.
6. Operators shall through specialized software resident on a workstation be able to create, modify, verify, upload, download, and delete control algorithm databases resident in the field controllers and mirrored in the workstation database.
7. All DDC hardware and software shall be designed and manufactured by U.S. corporations. All hardware shall be Listed Underwriters Laboratory for Open Energy Management Equipment (PAZX) under the U.L. standard for safety 916, with integral labels showing rating.

D. Quality Assurance

1. Responsibility: The supplier of the Building Control System shall be responsible for inspection and Quality Assurance (QA) for all materials and workmanship furnished by him.
2. Component Reliability: Each and every controller, sensor, and all other DDC components shall be individually tested by the manufacturer prior to shipment. All products used in this installation shall be new, currently under manufacture, and shall be applied in similar installations for a minimum of 2 years. Spare parts shall be available for at least 5 years after completion of this contract.
3. Tools, Testing and Calibration Equipment: The BCS supplier shall provide all tools, testing and calibration equipment necessary to ensure the reliability and accuracy of the control system.
4. Installer experience: The installer shall have an established working relationship with the BCS Manufacturer for not less than three years, have a minimum of five years documented experience in BCS installations, and be approved and certified by the Manufacturer or their authorized Distributors.

1.4 SUBMITTALS

A. Contractor submittal procedures:

1. Transmit each submittal with Architect/Engineer accepted form.
2. Sequentially number transmittal forms. Mark revised submittals with original number and sequential alphabetic suffix.
3. Identify Project, Contractor, subcontractor and supplier; pertinent drawing and detail number, and specification section number, appropriate to submittal.
4. Apply Contractor's stamp, signed or initialed certifying that review, approval, verification of products required, field dimensions, adjacent construction Work, and coordination of information is in accordance with requirements of the Work and Contract Documents.
5. Schedule submittals to expedite Project, and deliver to Engineer at business address. Coordinate submission of related items.

6. For each submittal for review, allow 7 calendar days excluding delivery time to and from Contractor.
7. Identify variations from Contract Documents and product or system limitations which may be detrimental to successful performance of completed Work.
8. Allow space on submittals for Contractor and Architect/Engineer review stamps.
9. When revised for resubmission, identify changes made since previous submission.
10. Distribute copies of reviewed submittals as appropriate. Instruct parties to promptly report inability to comply with requirements.
11. Submittals not requested will not be recognized or processed.

B. Drawings:

1. The system supplier shall submit engineered drawings, control sequences, bill of materials, bus riser diagrams, hardware/software product data sheets, and applicable valve and damper schedules for approval.
2. Drawings shall be submitted in the following standard sizes: 11" x 17"
3. Two complete sets of submittal drawings shall be provided.
4. Drawings shall be provided to Owner in unlocked PDF format.

C. Operation and Maintenance Manuals:

Manuals will be provided prior to final acceptance and shall include:

1. Installation instructions.
2. Principles of operation and a detailed system description
3. Startup and operating instructions
4. System layout and interconnection schematic diagrams
5. Routine preventive maintenance procedures and corrective diagnostic troubleshooting procedures.
6. Name, address and telephone number of the DDC Systems field representative.
7. Complete recommended spare parts list.

1.5 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.
1. Revise shop drawings to reflect actual installation and operating sequences.
 2. Submit data specified in "Submittals" in final "Record Documents" form.

B. Operation and Maintenance Data:

1. Submit interconnection wiring diagrams complete field installed systems with identified and numbered, system components and devices.
2. Submit inspection period, methods, and materials recommended.

1.6 ACCEPTABLE MANUFACTURERS

- A. BCS Basis-of-Design: I-Vu Open.

1.7 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.8 WARRANTY

- A. Warranty shall cover all costs for parts, labor, associated travel, and expenses for a period of one year from completion and acceptance by the owner, except for damages from other causes.
- B. Hardware and software personnel supporting this warranty agreement shall provide on-site or off-site service in a timely manner after failure notification to the vendor. The maximum acceptable response time to provide this service at the site shall be 24 hours during normal business hours.
- C. This warranty shall apply equally to both hardware and software and be at no cost to the owner.

PART 2 SEQUENCES OF OPERATION

- 2.1 See plans for sequences of operation.

PART 3 PRODUCTS

3.1 Hardware

- A. Communication Wire
 - 1. Wiring and Raceways - Communications Bus (When Part of a Network)
 - a. Provide copper wiring, plenum cable, and raceways required for installation and operation of equipment as described in this section.
 - b. All insulated wire to be stranded copper conductors; UL labeled for 90C minimum service.
 - c. The Communications Bus shall be a three-conductor cable with shield. EIA Standard RS-485 Communication's protocol shall be employed. The communications bus shall comply with FCC Part 15, Subpart J, Class A for bus radiated and conductive noise.
 - d. Communications Bus shall be capable of having multiple system elements connected. Each Communications Bus shall allow for the use of modules as an interface to secondary Buses.
 - e. Whenever the Communications Bus enters or leaves a building, the Bus shall be provided with adequate lightning suppression devices.
 - f. The Communications Bus shall be capable of communicating via Ethernet or Modem to a remote building. This interface shall allow any EMS operator's station, as applicable, to communicate with any other remotely located, compatible, communications bus.
- B. Communication Wire - Ethernet
 - 1. Wiring and Raceways - Communications Bus (When Part of a Network) General:
 - a. Provide copper wiring, plenum cable, and raceways required for installation and operation of equipment as described in this section.
 - b. All insulated wire to be stranded copper conductors, UL labeled for 90C minimum service.

- c. The Communications Bus shall be a three-conductor cable with shield. EIA Standard RS-485 Communication's protocol shall be employed. The communications bus shall comply with FCC Part 15, Subpart J, Class A for bus radiated and conductive noise.
- d. Communications Bus shall be capable of having multiple system elements connected. Each Communications Bus shall allow for the use of modules as an interface to secondary Buses.
- e. Whenever the Communications Bus enters or leaves a building, the Bus shall be provided with adequate lightning suppression devices.
- f. The Communications Bus shall be capable of communicating through a telephone modem to a remote building. This interface shall allow any EMS operator's station, as applicable, to communicate with any other remotely located, compatible, communications bus.

2. Network Communications

The communications infrastructure shall be capable of supporting a two-tiered physical architecture consisting of an RS-485 Layer and Ethernet Layer. All controllers and system interface devices shall maintain a peer-to-peer flat, logical, communications architecture from either physical layer. The infrastructure shall rely on the use of communications routers that will encapsulate messages on the RS-485 layer and pass them to or through the Ethernet layer. These routers shall provide a seamless, transparent connection from the RS-485 layers or segments to an Ethernet backbone, network, as well as to computers with a direct Ethernet connection. The Ethernet routers shall have full communication capability with the DDC network without loss of dynamic data or functional control tables.

The RS-485 communications segments shall have the capability to be connected using a minimum of 200 Ethernet routers in order to extend the RS-485 communications segments over the Ethernet. The Ethernet routers shall support flexible Internet Protocol addressing. The Ethernet routers shall support either static or Dynamic Host IP address assignments. Addressing shall be capable of being done in more than one way. A standard Windows tool such as HyperTerminal shall allow a non-HVAC technician to commission the Ethernet router. The Ethernet router shall also be able to be fully commissioned using a standard commissioning tool that an HVAC technician is familiar with.

The Ethernet router shall have the following minimum components and capabilities:

- a. 32 Bit Micro Processor
- b. 10Base-T Ethernet Port
- c. RS232 Console Port
- d. RS485 Network Port
- e. Status and Communication LED's

C. Field Sensors: Common Field Sensors

1. Space Temperature Sensors: Space Temperature Sensors shall be 5,000 or 10,000-ohm thermistors or resistance temperature detector types with wall plate adapter and blank cover assembly. The sensor shall include an integral occupancy override button, and a space temperature adjustment mechanism. 1

Space temperature setpoint should be digitally displayed on the device.

2. Duct Temperature Sensors: Duct Temperature Sensors shall be 1000-ohm single point or averaging type as need. Averaging sensors shall be RTDs, or 10,000-ohm averaging thermistors. Single point sensors shall be 5,000 ohm or 10,000-ohm thermistors. Provide a supply air temperature sensor for each Rooftop Unit and Split System
3. Outside Air Sensors: Outside Air Sensor shall be 5,000 or 10,000-ohm thermistor, with integral PVC housing and ½” NPT conduit connector.
4. Space and Duct Relative Humidity Sensors: Space Relative Humidity Sensors shall and have a range of 0-100% RH. The measuring accuracy shall be between 2% and 5% as indicated on the plans over the range of the device.
5. Outdoor Air Relative Humidity Sensors: Outdoor Relative Humidity Transmitters shall be enclosed in a weather-tight junction box and measure outdoor air humidity from 0% to 100% with accuracy between 2% and 5% as needed to fit the application. Transmitters shall not require calibration and shall provide a 2-wire 4-20 mA, 3 wire 0-5 Vdc, or 3 wire 0-10Vdc output signal.
6. Space CO2 Sensor with Temperature Sensors: The wall mounted combination sensors shall contain a space temperature sensor and Carbon Dioxide (CO2) sensor in a single. The CO2 sensor shall use single-beam absorption infrared diffusion technology and be self-calibrating. The CO2 range shall be 0-2000 PPM with analog outputs of 4-20 ma or 0-10 v. with a power source of 18-30 Vac, 50/60 Hz. The accuracy shall be +/- 100 PPM at 60F to 90F. The sensor shall include an integral occupancy override button, a set point adjustment slider bar, and an RJ14 communication port.
7. Status Indication: A current sensing or differential pressure device shall provide status indication for fans and pumps. The current sensing device shall be installed at the motor starter or motor to provide load indication. The device shall consist of a current transformer, a solid state current sensing circuit with adjustable trip point, and a solid state or contact switch. A red light emitting diode (LED) shall indicate the ON OFF status of the unit. The switch shall provide a N.O. contact for wiring back to the General Purpose Controller.

A differential pressure sensing device shall be installed across the fan or pump and utilize two sensing elements to provide pressure indication. The device shall operate a SPDT switch with adjustable trip point contact for wiring back to the General Purpose Controller.
8. Start-Stop Status Relays: Start/Stop and Status Relays shall be designed to plug into a screw terminal-mounting socket. Relays shall be single pole, or double pole as required with double throw contacts rated for required duty. Magnetic Latching Type Control Relay coils shall be activated by a pulsed input and shall maintain condition even during a power failure. A built-in indicator shall show set/reset condition.

9. Power Supplies and Transformers: Power Supplies and Voltage Transformers shall convert 120 Vac primary supply voltage into 24 Vac or 24 Vdc control voltage as needed.

D. Application Specific Controllers

1. Equipment Controller (EC) shall control all associated HVAC equipment functions, and be capable of stand-alone or networked operation. The resident algorithms shall use error reduction logic as designated in ASHRAE standard 90.1 to provide temperature control and energy usage.
2. The EC must conform to a standard BACnet Device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L unless otherwise specified.
3. BACnet. The EC shall conform to BACnet Application Specific Controller (B-ASC) device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L and shall be listed as a certified B-ASC in the BACnet Testing Laboratories (BTL) Product Listing. RTC shall reside on a BACnet network using the MS/TP Data Link/Physical layer protocol.
4. Communication.
 - a. Service Port. EC shall provide a service communication port for connection to a Portable Operator's Terminal. Connection shall be extended to space temperature sensor ports where shown on drawings.
5. Environment. Controller hardware shall be suitable for anticipated ambient conditions.
 - a. EC shall be mounted in waterproof enclosures and shall be rated for operation at -29°C to 60°C (-20°F to 140°F).
6. Memory.
 - a. The Controller shall have a Non-Volatile Memory providing indefinite storage of application and configuration data.
 - b. Controller memory shall support operating system, database, and programming requirements.
7. Controller Time.
 - a. Controller shall feature and maintain a 365-day Real-Time Clock/Calendar with holiday functions. Controller shall account for time changes related to Daylight Savings Time.
8. Stand alone capability. The controller shall be capable of providing all control functions of the HVAC system without the use of a computer.
 - a. It shall establish occupancy scheduling based on its own local occupancy schedule, the closure of a contact connected to an external time clock or BMS system, or by a timed override request (1 to 24 hours) through its space temperature sensor override button.
 - b. Each piece of equipment shall be controlled by a single controller to provide stand-alone control in the event of communication failure. All I/O points specified for a piece of equipment shall be integral to its controller. Provide stable and reliable stand-alone control using default values or other method for values normally read over the network.
9. Networked capability. The controllers shall include the inherent capability to access the system control selections as well as to monitor system performance by means of a communicating network with a PC and BMS software program.
 - a. When networked, EC occupancy may be established by user interface or occupancy signal from other controller located in network.
10. Scheduling. EC shall provide the following schedule options as a minimum:

- a. Weekly. Provide separate schedules for each day of the week. Each schedule shall be able to include up to 5 occupied periods (5 start-stop pairs or 10 events).
 - b. Exception. Operator shall be able to designate an exception schedule for each of the next 365 days. After an exception schedule has executed, system shall discard and replace exception schedule with standard schedule for that day of the week.
 - c. Holiday. Operator shall be able to define 24 special or holiday schedules of varying length on a scheduling calendar that repeats each year.
11. Serviceability.
 - a. Controller shall have diagnostic LEDs for power, communication, and processor.
 - b. Controller in the system shall continually check its processor and memory circuit status and shall generate an alarm on abnormal operation. System shall continuously check controller network and generate alarm for each controller that fails to respond.
 12. Immunity to Power and Noise. Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).
 13. Hand held or wall mounted local interface device that allow configuration access shall be password protected with minimum of two levels of security. Level one shall provide limited access to controller operational parameters and level two shall provide full access to controller operational and configuration parameters.
 14. Alarm Processing. The controller shall contain a routine to process alarms. Alarm processing logic shall also monitor return to normal conditions as part of the alarm scan. The operator will have the ability to modify the alarm/alert priority level.
 15. Demand Limiting. Upon receiving network signal the controller shall be capable of providing separate heating and cooling demand control utilizing two independent demand inputs.
 16. Anti-Short Cycling. Binary output objects shall be protected from short cycling by means of preconfigured minimum on-time and off-time settings, customized for the specific requirements of the application.
 17. On and Off Control with Differential. System shall provide direct- and reverse-acting on and off algorithms with adjustable differential to cycle a binary output based on a controlled variable and set point.
 18. Keypad. Where specified provide a local keypad and display for each ASC. Operator shall be able to use keypad to view and edit data. Keypad and display shall require password to prevent unauthorized use. If the manufacturer does not normally provide a keypad and display for each BC and ASC, provide the software and any interface cabling needed to use a laptop computer as a Portable Operator's Terminal for the system.
 19. Capacity control shall be based on the use of a conventional thermostat, or programmable thermostat, or alternatively, a constant volume unit may utilize its own internal time clock and set points (cooling and heating) coupled with a room sensor for capacity control. The controls shall provide separate occupied and unoccupied cooling and heating set points – except if a conventional thermostat is used.
 20. Economizer control. The EC shall provide analog output signal for economizer control.

- E. Products - STANDARD CONTROL HARDWARE:
1. Supply Air Sensor: The factory-supplied sensor shall be a thermistor type (RTDs shall also be acceptable). The sensor shall be field installed to properly measure the unit supply air temperature. The sensor shall be field wired to the controller.
 2. Space Temperature Sensor: The space temperature sensor shall be field-supplied for field installation as shown on the plans. The sensor shall be communicating with display and warmer/cooler adjustment buttons to adjust the heating and cooling set points as detailed in the I/O (Input/Output) list, shown on the plans, or mentioned elsewhere within this specification.
 3. Indoor Air Fan, Cooling, and Heating Stages relays: The relays (SPDT) shall be integrated in the controller field wired to equipment contactors or relays. Pilot relays shall be field-supplied and wired as applicable inside the equipment or control panel.
 4. Outside-Air Sensor: The sensor shall be a thermistor type, factory supplied for each air handler for field mounting and wiring. The sensor shall be installed upstream from the outside air economizer damper where it shall accurately sense the temperature of the outside air entering the mixing box. Each air handler shall include its own outside-air sensor unless a common outside air plenum is serving all units.
 5. Fan Status Indication: A current sensing sensor shall provide status indication. The sensor shall be installed at the motor starter or motor to provide load indication. The unit shall consist of a current transformer, a solid-state current sensing circuit (with adjustable set point) and a solid-state switch. A red light-emitting diode (LED) shall indicate the on/off status of the unit. The switch shall provide an N.O. (normally open) contact for wiring back to the controller.
 6. User Interface: Each controller shall be capable of interfacing to a front-end operator workstation located on the network, or portable PC plugged into the controller's communications port, or a communicating Linkage thermostat for configuring, altering the controller configuration, setting address, uploads, downloads, etc.

3.2 Software: Front End i-Vu Open.

PART 4 PRODUCTS

4.1 Operator Interface

- A. Description. The control system shall be as shown and consist of a high-speed, peer-to-peer network of DDC controllers and a stand alone web server operator interface. Depict each mechanical system and building floor plan by a point-and-click graphic. A web server shall gather data from this system and generate web pages accessible through a conventional web browser on each PC connected to the network. Operators shall be able to perform all normal operator functions through the web browser interface. Operators with sufficient access level shall have an ability to make changes to all system and equipment graphics in the web server in addition to having full DDC system access to

make configuration changes to the control system. Any tools required for making graphic changes shall be provided with web server.

- B. **Operator Interface.** Furnish one Web server interface as shown on the system drawings. Operators shall be able to access all necessary operational information in the DDC system via client computer utilizing IE web browser. Client computer and IE web browsing software shall not be furnished under this section.
1. Web server shall connect via the LAN and be able to simultaneously serve up controller information to multiple operators connected via LAN with IE web browsers. Each client web browser connected to server shall be able to access all system information.
 2. Web server shall be compatible with Wireless Access Protocol (WAP) enabled cellular telephone or personal digital assistant (PDA). The PDA/WAP interface may be text-based and shall provide a summary of the most important data.
 3. With the use of a remote SMTP email server the operators interface web server shall be able to notify personnel of an alarm or record information about an alarm in the DDC system.
- C. **Web Server Hardware.** Furnish one compact web server with Ethernet port for LAN or direct operator client computer access. The web server shall be capable of communicating to the peer to peer DDC controller network. Any required installation or commissioning software shall be pre-installed on the web server. Installation or commissioning of the web server shall be done through a client computer with a standard web browser.
- D. **Communication.** Web server or workstation and controllers shall communicate using BACnet protocol. Web server or workstation and control network backbone shall communicate using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing as specified in ANSI/ASHRAE 135-2004, BACnet Annex J.
- E. **Operator Functions.** Operator interface shall allow each authorized operator to execute the following functions as a minimum:
1. **Log In and Log Out.** System shall require user name and password to log in to operator interface.
 2. **Point-and-click Navigation.** Operator interface shall be graphically based and shall allow operators to access graphics for equipment and geographic areas using point-and-click navigation.
 3. **View and Adjust Equipment Properties.** Operators shall be able to view controlled equipment status and to adjust operating parameters such as set points, PID gains, on and off controls, and sensor calibration.
 4. **View and Adjust Operating Schedules.** Operators shall be able to view scheduled operating hours of each schedulable piece of equipment on a weekly or monthly calendar-based graphical schedule display, to select and adjust each schedule and time period, and to simultaneously schedule related equipment. System shall clearly show exception schedules and holidays on the schedule display.
 5. **View and Respond to Alarms.** Operators shall be able to view a list of currently active system alarms, to acknowledge each alarm, and to clear (delete) unneeded alarms. Remote users shall be able to receive alarms via emails or cell phone text messages.
 6. **View and Configure Trends.** Operators shall be able to view a trend graph of each trended point and to edit graph configuration to display a specific time

- period or data range. Operator shall be able to create custom trend graphs to display on the same page data from multiple trended points.
7. View and Configure Reports. Operators shall be able to run preconfigured reports, to view report results, and to customize report configuration to show data of interest.
 8. Manage Control System Hardware. Operators shall be able to view controller status, to restart (reboot) each controller, and to download new control software to each controller.
 9. Manage Operator Access. Typically, only a few operators are authorized to manage operator access. Authorized operators shall be able to view a list of operators with system access and of functions they can perform while logged in. Operators shall be able to add operators, to delete operators, and to edit operator function authorization. Operator shall be able to authorize each operator function separately.
- F. System Software.
1. Operating System and required software. Web server operator interface shall be a self contained web server without the need for any type of maintenance. Any required operating system or software shall be factory loaded and maintenance free.
 2. System Graphics. Operator interface shall be graphical and shall include at least one graphic per piece of equipment or occupied zone, graphics for each chilled water and hot water system, and graphics that summarize conditions on each floor of each building included in this contract. Indicate thermal comfort on floor plan summary graphics using dynamic colors to represent zone temperature relative to zone set point.
 - a. Functionality. Graphics shall allow operator to monitor system status, to view a summary of the most important data for each controlled zone or piece of equipment, to use point-and-click navigation between zones or equipment, and to edit set points and other specified parameters.
 - b. Animation. Graphics shall be able to animate by displaying different image files for changed object status.
 - c. Alarm Indication. Indicate areas or equipment in an alarm condition using color or other visual indicator.
 - d. Format. Graphics shall be saved in an industry-standard format such as BMP, JPEG, PNG, or GIF. Web-based system graphics shall be viewable on browsers compatible with World Wide Web Consortium browser standards. Web graphic format shall require no plug-in (such as HTML and JavaScript) or shall only require widely available no-cost plug-ins (such as Active-X and Macromedia Flash).
- G. System Tools. System shall provide the following functionality to authorized operators as an integral part of the operator interface or as stand-alone software programs. If furnished as part of the interface, the tool shall be available from each workstation or web browser interface. If furnished as a stand-alone program, software shall be installable on standard Windows compatible PCs with no limit on the number of copies that can be installed under the system license.
1. Automatic System Database Configuration. Each web server shall store internally store a copy of the current system database, including controller firmware and software. Stored database shall be automatically updated with each system configuration or controller firmware or software change.

2. Controller Memory Download. Operators shall be able to download memory from the system database to each controller.
3. System Configuration. Operators shall be able to configure the system.
4. Online Help. Context-sensitive online help for each tool shall assist operators in operating and editing the system.
5. Security. System shall require a user name and password to view, edit, add, or delete data.
 - a. Operator Access. Each user name and password combination shall define accessible viewing, editing, adding, and deleting functions in each system application, editor, and object.
 - b. Automatic Log Out. Automatically log out each operator if no keyboard or mouse activity is detected. Operators shall be able to adjust automatic log out delay.
 - c. Encrypted Security Data. Store system security data including operator passwords in an encrypted format. System shall not display operator passwords.
6. System Diagnostics. System shall automatically monitor controller and I/O point operation. System shall annunciate controller failure and I/O point locking (manual overriding to a fixed value).
7. Alarm Processing. System input and status objects shall be configurable to alarm on departing from and on returning to normal state. Operator shall be able to enable or disable each alarm and to configure alarm limits, alarm limit differentials, alarm states, and alarm reactions for each system object. Configure and enable alarm points as specified in Points List. Alarms shall be BACnet alarm objects and shall use BACnet alarm services.
8. Alarm Messages. Alarm messages shall use an English language descriptor without acronyms or mnemonics to describe alarm source, location, and nature.
9. Alarm Reactions. Operator shall be able to configure (by object) actions workstation or web server shall initiate on receipt of each alarm. As a minimum, workstation or web server shall be able to log, print, start programs, display messages, send e-mail, send page, and audibly annunciate.
10. Alarm Maintenance. Operators shall be able to view system alarms and changes of state chronologically, to acknowledge and delete alarms, and to archive closed alarms to the workstation or web server from each workstation or web browser interface.
11. Trend Configuration. Operator shall be able to configure trend sample or change of value (COV) interval, start time, and stop time for each system data object and shall be able to retrieve data for use in spreadsheets and standard database programs. Controller shall sample and store trend data and shall be able to archive data to the hard disk. Configure trends as specified in Points List. Trends shall be BACnet trend objects.
12. Object and Property Status and Control. Operator shall be able to view, and to edit if applicable, the status of each system object and property by menu, on graphics.
13. Reports and Logs. Operator shall be able to select, to modify, to create, and to print reports and logs. Operator shall be able to store report data in a format accessible by standard spreadsheet and word processing programs.
14. Standard Reports. Furnish the following standard system reports:
 - a. Reports shall be filtered based upon the selected equipment
 - b. Alarm Reports
 - c. Alarm Summary - Current alarms

- d. Alarm Sources – List of equipment and associated alarm conditions
 - e. Alarm Actions – Configured alarm actions such as e-mail and alarm pop-up
 - f. Schedule Reports
 - g. Effective Schedules – Displays effective schedules for each equipment
 - h. Schedule Instances – Displays all schedules entered
 - i. Security Reports – Maintains audit of all actions taken through user interface
 - j. Commissioning Reports – Provide equipment checkout status and notes
 - k. Equipment Reports – Provide reports showing trended points and available network points
1. Custom Reports. Operator shall be able to create custom reports that retrieve data, including archived trend data, from the system, that analyze data using common algebraic calculations, and that present results in tabular or graphical format. Reports shall be launched from the operator interface.
 2. Graphics Generation. Graphically based tools and documentation shall allow Operator to edit system graphics, to create graphics, and to integrate graphics into the system. Operator shall be able to add analog and binary values, dynamic text, static text, and animation files to a background graphic using a mouse.
 3. Graphics Library. Complete library of standard HVAC equipment graphics shall include equipment such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. Library shall include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. Library graphic file format shall be compatible with graphics generation tools.
- H. Portable Operator's Terminal. Provide all necessary software to configure an IBM-compatible laptop computer for use as a Portable Operator's Terminal. Operator shall be able to connect configured Terminal to the system network or directly to each controller for programming, setting up, and troubleshooting.
- I. Timed override reporting
1. The DDC system shall track all push button timed override events during unoccupied periods. The system shall store time of the override event and time duration for each override event.
 2. Web server shall allow operators to create custom reports detailing timed override events. Timed override reports shall allow the following options:
 3. Minimum billing time. A minimum amount of time that each override event will last.
 4. Billing rate. A monetary rate per hour or per minute of the override duration.
 5. Exemption times. A defined block of time during each week that is exempt from detecting override events.
 6. Allowances. A dollar amount of override usage that is allowed per tenant and is given at no charge. This allowance will be subtracted from the tenant's total override usage.
- J. Web services data exchange (i-Vu Plus only)
System shall support Web services data exchange with any other system that complies with XML (extensible markup language) and SOAP (simple object access protocol)

standards specified by the Web Services Interoperability Organization (WS-I) Basic Profile 1.0 or higher. Web services support shall as a minimum be provided at the workstation or web server level and shall enable data to be read from or written to the DDC system.

1. System shall support Web services read data requests by retrieving requested trend data or point values (I/O hardware points, analog value software points, or binary value software points) from any system controller or from the trend history database.
2. System shall support Web services write data request to each analog and binary object that can be edited through the system operator interface by downloading a numeric value to the specified object.
3. For read or write requests, the system shall require user name and password authentication and shall support SSL (Secure Socket Layer) or equivalent data encryption.
4. System shall support discovery through a Web services connection or shall provide a tool available through the Operator Interface that will reveal the path/identifier needed to allow a third party Web services device to read data from or write data to any object in the system which supports this service.

PART 5 EXECUTION

5.1 EXAMINATION

- A. Verify field end devices, wiring, and pneumatic tubing is installed prior to installation proceeding.
- B. Prior to starting work, carefully inspect installed work of other trades and verify that such work is complete to the point where work of this Section may properly commence.
- C. Notify the Owners Representative in writing of conditions detrimental to the proper and timely completion of the work.

5.2 INSTALLATION

- A. Install control units and other hardware in position on permanent walls where not subject to excessive vibration.
- B. Install software in control units and in operator workstation. Implement features of programs to specified requirements and appropriate to sequence of operation.
- C. Install hardware and software in accordance with manufacturer's instructions.
- D. Provide all miscellaneous devices, hardware, software, interconnections installation and configuration required to insure a complete operating system in accordance with the sequences of operation and point schedules.
- E. All wiring shall be installed as continuous lengths, where possible. Any required splices shall be made only within an approved junction box or other approved protective device.

- F. Install equipment, piping, and wiring/raceways parallel to building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible.
- G. Locate and install components for easy accessibility; in general, mount 60 inches above floor with minimum 3'-0" clear access space in front of units. Obtain approval on locations from Owner's representative prior to installation.
- H. All instruments, switches, transmitters, etc., shall be suitably wired and mounted to protect them from vibration, moisture and high or low temperatures.
- I. Identify all equipment and panels. Provide permanently mounted tags for all panels.
- J. Provide stainless steel or brass thermowells suitable for respective application and for installation under other sections; sized to suit pipe diameter without restricting flow.

5.3 INTERLOCKING AND CONTROL WIRING

- A. Provide all interlock and control wiring. All wiring shall be installed in a neat and professional manner in accordance with Specification Division 16 and all national, state and local electrical codes.
- B. Provide wire and wiring techniques recommended by equipment manufacturers.
- C. Control wiring shall not be installed in power circuit raceways. Magnetic starters and disconnect switches shall not be used as junction boxes. Provide auxiliary junction boxes as required. Coordinate location and arrangement of all control equipment with the Owner's representative prior to rough-in.
- D. Provide auxiliary pilot duty relays on motor starters as required for control function.
- E. Provide power for all control components from nearest electrical control panel or as indicated on the electrical drawings; coordinate with electrical contractor.
- F. All control wiring in the mechanical, electrical, telephone and boiler rooms to be installed in raceways. All other wiring to be installed in a neat and inconspicuous manner per local code requirements.
- G. When a cable enters or exits a building, a surge suppressor must be installed. The surge suppressor shall be installed according to the manufacturer's instructions.
- H. All sensor wiring shall be labeled to indicate the origination and destination of data.

5.4 MANUFACTURER'S FIELD SERVICES

- A. Start and commission systems. Allow adequate time for start-up and commissioning prior to placing control systems in permanent operation. Replace any equipment found to be defective.
- B. Furnish service technician employed by system installer to instruct Owner's representative in operation of systems and equipment for up to an 8 hour period. Training to be furnished on site.

- C. Provide the capability for off-site monitoring. As a minimum, off-site facility shall be capable of system diagnostics and software download.
- D. Provide Owner's Representative with spare parts list. Identify equipment critical to maintaining the integrity of the operating system.
- E. Provide the Owners Representative an in warranty maintenance proposal.

5.5 DEMONSTRATION AND TRAINING

- A. Furnish basic operator training for up to 3 persons on data display, alarm and status descriptors, requesting data, execution commands and log requests. Include a minimum of 8 hours instructor time. Furnish training on site.
- B. Demonstrate complete and operating system to Owner.
- C. Provide certificate stating that control system has been tested and adjusted for proper operation.

END OF SECTION

SECTION 23 20 00 - HVAC PIPING AND PUMPS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pipe and pipe fittings.
 - 2. Valves.
 - 3. Piping specialties.
 - 4. HVAC piping specialties.
 - 5. HVAC pumps.
 - 6. Chemical treatment.

1.2 SUBMITTALS

- A. Product Data:
 - 1. Pipe Hangers and Supports: Submit manufacturers catalog data including load carrying capacity.
 - 2. Valves: Submit Manufacturers catalog information with valve data and ratings for each service.
 - 3. Piping Specialties: Submit product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes. Submit schedule indicating manufacturer, model number, size, location, rated capacity, load served, and features for each specialty.
 - 4. Pipe Expansion Products: Indicate maximum temperature and pressure rating, and maximum expansion compensation.
 - 5. Pumps: Submit pump type, capacity, certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements. Include manufacturers catalogue information.
 - 6. Chemical Treatment: Submit chemical treatment materials, chemicals, and equipment.
- B. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: Submit spare parts lists and maintenance procedures.

1.4 WARRANTY

- A. Furnish five year manufacturer warranty for pumps.

1.5 MAINTENANCE SERVICE

- A. Furnish maintenance services of chemical water treatment for one year from Date of Substantial Completion.

- B. Furnish chemicals for treatment and testing during warranty period.
- C. Furnish one extra set of mechanical seals for pumps.

PART 2 PRODUCTS

2.1 Acceptable Manufacturers

- A. Gate, globe, ball, butterfly, and check valves: Crane, Hammond, Nibco, Milwaukee, Watts, Stockham.
- B. Plug Valves: DeZurkik, Flow Control Equipment, Homestead Valve.

2.2 HEATING WATER PIPING, ABOVE GROUND

- A. Steel Pipe: ASTM A53/A53M, Schedule 40, black.
 - 1. Fittings: ASME B16.3, malleable iron or ASTM A234/A234M, forged steel welding type.
 - 2. Joints: Threaded for pipe 2 inch and smaller; welded for pipe 2-1/2 inches and larger.
- B. Copper Tubing: ASTM B88, Type L, drawn.
 - 1. Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
 - 2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F.

2.3 CHILLED WATER PIPING, ABOVE GROUND

- A. Steel Pipe: ASTM A53/A53M, Schedule 40, black.
 - 1. Fittings: ASME B16.3, malleable iron or ASTM A234/A234M, forged steel welding type.
 - 2. Joints: Threaded for pipe 2 inch and smaller; welded for pipe 2-1/2 inches and larger.

2.4 EQUIPMENT DRAINS AND OVERFLOWS

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

2.5 FLUE AND COMBUSTION AIR PIPING

- A. PVC Pipe: ASTM D1785, Schedule 40, polyvinyl chloride (PVC) material.
 - 1. Fittings: ASTM D2466, Schedule 40, PVC.
 - 2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement. Prime joints with a contrasting color.
 - 3. Wrap pipes in HVAC plenums with 3M Plenum Wrap 5A+ per manufacturer's instructions.

- B. CPVC Pipe: ASTM F441/F441M, Schedule 40, chlorinated polyvinyl chloride (CPVC) material.
 - 1. Fittings: ASTM F438, CPVC, Schedule 40, socket type.
 - 2. Joints: ASTM D2846/D2846M, solvent weld with ASTM F493 solvent cement. Prime joints with a contrasting color.
 - 3. Wrap pipes in HVAC plenums with 3M Plenum Wrap 5A+ per manufacturer's instructions.

2.6 VALVES

- A. Gate Valves:
 - 1. Up to 2 inches: Bronze body, bronze trim, non-rising stem, hand wheel, inside screw, double wedge disc, soldered or threaded.
 - 2. Over 2 inches: Iron body, bronze trim, rising stem, hand wheel, OS&Y, solid wedge, flanged or grooved ends.
- B. Globe Valves:
 - 1. Up to 2 Inches: Bronze body, bronze trim, rising stem and hand wheel, inside screw, renewable composition disc, solder or threaded ends, with back seating capacity.
 - 2. Over 2 inches: Iron body, bronze trim, rising stem, hand wheel, OS&Y, plug type disc, flanged ends, renewable seat and disc.
- C. Ball Valves:
 - 1. Up to 2 inches: Bronze or stainless steel one piece body, chrome plated brass ball, teflon seats and stuffing box ring, lever handle, solder or threaded ends.
 - 2. Over 2 inches: Cast steel flanged body, chrome plated steel ball, Teflon seat and stuffing box seals and lever handle.
- D. Plug Valves:
 - 1. Up to 2 inches: Bronze body, bronze tapered plug, non-lubricated, Teflon packing, threaded ends.
 - 2. Over 2 inches: Cast iron body and plug, pressure lubricated, Teflon packing, flanged ends.
- E. Butterfly Valves:
 - 1. Up To 2 inches: Bronze body, stainless steel disc, resilient replaceable seat, threaded ends, extended neck, lever handle with memory stop.
 - 2. Over 2 inches: Iron body, chrome plated iron disc, resilient replaceable seat, wafer or lug ends, extended neck, 10 position lever handle.
- F. Swing Check Valves:
 - 1. Up to 2 inches: Bronze body and swing disc, solder or threaded ends.
 - 2. Over 2 inches: Iron body, bronze trim, swing disc, renewable disc and seat, flanged ends.
- G. Spring Loaded Check Valves:
 - 1. Iron body, bronze trim with threaded, wafer or flanged ends and stainless steel spring with renewable composition disc.

H. Relief Valves:

1. Bronze body, Teflon seat, stainless steel stem and springs, automatic, direct pressure actuated capacities ASME certified and labeled.

2.7 PIPING SPECIALTIES

A. Flanges, Unions, and Couplings:

1. Pipe Size 2 inches and Under: Malleable iron unions for threaded ferrous piping; bronze unions for copper pipe, soldered joints.
2. Pipe Size Over 2 inches: Forged steel flanges for ferrous piping; bronze flanges for copper piping; preformed neoprene gaskets.
3. Grooved and Shouldered Pipe End Couplings: Malleable iron housing, C-shape elastomer composition sealing gasket, steel bolts, nuts, and washers.
4. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

B. Strainers:

1. Size 2 inches and Under: Threaded brass or iron body for 175 psig working pressure, Y pattern with 1/32 inch stainless steel perforated screen.
2. Size 2-1/2 inch to 4 inch: Flanged iron body for 175 psig working pressure, Y pattern with 3/64 inch stainless steel perforated screen.
3. Size 5 inch and Larger: Flanged iron body for 175 psig working pressure, basket pattern with 1/8 inch stainless steel perforated screen.

C. Flexible Connectors:

1. Corrugated stainless steel or bronze hose with single layer of exterior braiding, minimum 9 inches long with copper tube ends; for maximum working pressure compatible with system pressures.

D. Air Vents:

1. Manual Type: Short vertical sections of 2 inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.
2. Float Type: Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.

E. Pressure Gages:

1. Gage: ASME B40.1, with bourdon tube, rotary brass movement, brass socket, front calibration adjustment, black scale on white background.
 - a. Case: Steel or Cast aluminum.
 - b. Dial Size: 3-1/2 inch diameter.
 - c. Mid-Scale Accuracy: two percent.
 - d. Scale: Psi.

F. Thermometers:

1. Stem Type Thermometer: ASTM E1, adjustable angle, red appearing mercury, lens front tube, cast aluminum case with enamel finish.
 - a. Size: 9 inch scale.
 - b. Window: Clear glass.

- c. Stem: Brass, 3/4" NPT, 3-1/2 inch long.
- d. Accuracy: 2 percent.
- e. Calibration: Degrees F.

2.8 HVAC PIPING SPECIALTIES

- A. Expansion Tanks:
 - 1. Construction: Closed, welded steel, ASME tested and labeled; cleaned, prime coated, and supplied with steel support saddles; with taps for installation of accessories. Equipment tag shall not be painted over or obstructed from view.
 - 2. Gage Glass Set: Brass compression stops, guard, and 3-1/2 inch glass.
 - 3. Automatic Cold Water Fill Assembly: Pressure reducing valve, reduced pressure double check back flow preventer, test cocks, strainer, vacuum breaker, and by-pass with valves.
- B. Air Separators:
 - 1. In-Line Air Separators: Cast iron for sizes 1-1/2 inch and smaller, or steel for sizes 2 inch and larger; ASME tested and stamped; for 125 psig operating pressure.
- C. Radiator Valves:
 - 1. Angle or straight pattern, rising stem, inside screw globe valve for 125 psig working pressure, with bronze body and integral union for threaded connections, renewable composition disc, plastic wheel handle for shut-off service, and lock shield key cap and set screw memory bonnet for balancing service.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify excavations are to required grade, dry, and not over-excavate.

3.2 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt, on inside and outside piping before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.3 INSTALLATION - INSERTS

- A. Install inserts for placement in concrete forms.
- B. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

- C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
- D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

3.4 INSTALLATION - PIPING SYSTEMS

- A. Install dielectric connections wherever jointing dissimilar metals.
- B. Install unions downstream of valves and at equipment or apparatus connections.
- C. Route piping parallel to building structure and maintain gradient.
- D. Install piping to maintain headroom. Group piping to conserve space. Group piping whenever practical at common elevations.
- E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- F. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
- G. Sleeve pipe passing through partitions, walls and floors.
- H. Install piping system allowing clearance for installation of insulation and access to valves and fittings.
- I. Install identification on piping systems including underground piping. Refer to plans.
- J. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

3.5 INSTALLATION - VALVES

- A. Install valves with stems upright or horizontal, not inverted.
- B. Install gate, ball, or butterfly valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- C. Provide lug end butterfly valves adjacent to equipment when functioning to isolate equipment.
- D. Install spring loaded check valves on discharge of pumps.
- E. Install globe valves or plug valves for general throttling service. Install non-lubricated plug valves only when shut-off or isolating valves are also installed.
- F. Install butterfly valves in heating water systems interchangeably with gate and globe valves.

- G. Install only butterfly valves in chilled water systems for throttling and shut-off service.
- H. Install 3/4 inch gate or ball drain valves at low points of piping, bases of vertical risers, and at equipment. Pipe to nearest drain.

3.6 INSTALLATION - PIPING SPECIALTIES

- A. Install one pressure gage for each pump, locate taps before strainers and on suction and discharge of pump; pipe to gage.
- B. Install pressure gages with pulsation dampers. Provide needle or ball valve to isolate each gage. Extend nipples to allow clearance from insulation.
- C. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inches for installation of thermometer sockets. Allow clearance from insulation.
- D. Install gages and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- E. Adjust gages and thermometers to final angle, clean windows and lenses, and calibrate to zero.
- F. Install manual air vents at system high points.
- G. For automatic air vents in ceiling spaces or other concealed locations, install vent tubing to nearest drain.
- H. Install air separator on suction side of system circulation pump and connect to expansion tank.
- I. Provide drain and hose connection with valve on strainer blow down connection.
- J. Provide radiator-balancing valves on water outlet, and shut off valves on water inlet for the following terminal heating unit types: radiators and unit heaters.
- K. Pipe relief valve outlet to nearest floor drain.
- L. Provide and install sample cooler for hot water and steam system water quality sampling.

3.7 INSTALLATION - HEATING AND COOLING PIPING

- A. Install heating water, chilled water in accordance with ASME B31.9 and ASME B31.1.
- B. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.
- C. Support tanks inside building from building structure.

- D. Install relief valves on pressure tanks, and expansion tanks. Pipe to floor drain (typ.).
- E. Select system relief valve capacity greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment. Install piping from relief valve outlet to nearest floor drain.
- F. Support piping adjacent to pump so no weight is carried on pump casings. For close coupled or base mounted pumps, install supports under elbows on pump suction and discharge line sizes **4 inches** and over.
- G. Install line size shut-off valve and strainer on pump suction. Install line size check valve, balancing valve, and shut-off valve on pump discharge.
- H. Install air cock and drain connection on horizontal pump casings. Install drain piping for bases and seals, piped to and discharging into floor drains. Lubricate pumps before start-up.
- I. Cleaning:
 - 1. After completion, fill, start, and vent prior to cleaning. Use water meter to record capacity in each system. Place terminal control valves in open position during cleaning.
 - 2. Add cleaner to closed systems at concentration as recommended by manufacturer.
 - 3. Hot Water Heating Systems: Apply heat and circulate for 12 hours minimum. Remove heat and cool; drain systems and refill with clean water. Circulate for 6 hours at design temperatures, then drain. Refill with clean water. Repeat until system cleaner is removed.
 - 4. Chilled Water Systems: Circulate for 48 hours, then drain. Refill with clean water, circulate for 24 hours, then drain. Refill with clean water. Repeat until system cleaner is removed.
 - 5. Flush open systems with clean water for one-hour minimum. Drain completely and refill.
 - 6. Remove, clean, and replace strainer screens. Disassemble system components to inspect and remove sludge. Flush low points with clean water after cleaning process is completed.

3.8 SCHEDULES

- A. Copper and Steel Pipe Hanger Spacing:

PIPE SIZE Inches	COPPER TUBING MAXIMUM HANGER SPACING Feet	STEEL PIPE MAXIMUM HANGER SPACING Feet	COPPER TUBING HANGER ROD DIAMETER Inches	STEEL PIPE HANGER ROD DIAMETER Inches

1/2	5	7	3/8	3/8
3/4	5	7	3/8	3/8
1	6	7	3/8	3/8
1-1/4	7	7	3/8	3/8
1-1/2	8	9	3/8	3/8
2	8	10	3/8	3/8
2-1/2 (Note 1)	9	11	1/2	1/2
3	10	12	1/2	1/2
4	12	14	1/2	5/8
5	13	16	1/2	5/8
6	14	17	5/8	3/4

B. Plastic Pipe Hanger Spacing:

PIPE HANGER SPACING		
PIPE MATERIAL	MAXIMUM HANGER SPACING Feet	HANGER ROD DIAMETER Inches
PVC (All Sizes)	4	3/8

C. Note 1: Refer to manufacturer's recommendations for grooved end piping systems.

END OF SECTION

SECTION 26 05 00 – ELECTRICAL GENERAL

PART 1 - GENERAL

1.1 SUMMARY

A. Description:

1. Provide all materials, tools, and labor for a complete electrical installation as required to accomplish the Work shown in the plans and specifications.
2. Procure all required permits and licenses.
3. Contractor to provide any and all electrical design or engineering required to accomplish the electrical portion of the Work shown in the plans and specifications. Provide stamped electrical engineering plans as required by the AHJ. Where the AHJ does not require electrical plans due to the work being supportive of or ancillary to the mechanical work on the project, provide electrical as-built plans on marked up mechanical sheets at the conclusion of the project.
4. Coordinate the electrical installation with the following:
 - a. Architect/Engineer
 - b. Contractors of other trades
 - c. Local Electrical and Building Inspectors, or the authority having jurisdiction
 - d. Local Utility companies serving the project

B. Related Documents:

1. All plans and specifications included in the Contract documents.

1.2 ABBREVIATIONS:

A. The following abbreviations are used throughout Division 16 specifications:

1. AFF: Above Finished Floor
2. ANSI: American National Standards Institute
3. ASTM: American Society for Testing and Materials
4. HVAC: Heating, Ventilating and Air Conditioning
5. IEEE: Institute of Electrical and Electronic Engineers
6. IES: Illuminating Engineering Society
7. ITL: Independent Testing Laboratories
8. NEC: National Electrical Code
9. NECA: National Electrical Contractor Association
10. NEMA: National Electrical Manufacturers Association
11. NFPA: National Fire Protection Association
12. NIC: Not in contract
13. UL: Underwriters Laboratories, Inc.
14. WP: Weatherproof
15. ADA: Americans with Disabilities Act

1.3 DEFINITIONS:

- A. "Provide" means to furnish and install, complete with all accessories so that component is functional

1.4 CODES AND STANDARDS:

- A. Comply with the following codes and published standards which are applicable to the electrical installation of this project:
 1. NFPA 70 – National Electrical Code, latest applicable edition with Georgia Amendments
 2. International Fire Code, latest applicable edition with Georgia Amendments
 3. International Building Code, latest applicable edition with Georgia Amendments
 4. Underwriters Laboratories Electrical Construction Directory ("green book")
 5. Underwriters Laboratories Electrical General Information ("white book")
 6. NFPA 72, latest applicable edition
 7. Georgia Accessibility Code
 8. Americans with Disabilities Act

1.5 STANDARDS FOR MATERIALS AND WORKMANSHIP:

- A. Use material that are new and, where UL or ITL has established standards, listed and/or labeled
- B. Organize and execute work so that finished appearance is neat; mechanical, plumb when vertical and level when horizontal

PART 2 - PRODUCTS

2.1 MATERIALS:

- A. Provide equipment, products and materials shown on the drawings, as specified in the specifications, or added by addendum

2.2 SUBSTITUTION OF MATERIALS:

- A. Refer to Contract Conditions.

2.3 PLYWOOD BACKBOARDS:

- A. 3/4" x size indicated on the drawings, A/D grade, paint two coats gray enamel

PART 3 - EXECUTION

3.1 PROTECTION OF MATERIALS:

- A. Cover fixtures, equipment and apparatus for protection against dirt, water, chemical or mechanical damage before and during construction.

- B. Keep all conduit and other openings protected against entry of foreign matter.
- C. Restore the original finish, including chop coat, of fixtures, apparatus or equipment that has been damaged prior to substantial completion.

3.2 COORDINATION:

- A. Prior to rough-in of any materials, coordinate with subcontractors the physical clearances for and sequencing of Division 26 work as it interfaces with and relates to architectural, structural, plumbing and HVAC systems.

3.3 OPERATIONAL TEST

- A. At the time of the substantial completion job observation, perform a test of all light fixtures, electrical systems, equipment, machinery and appliances, in the presence of the Architect or his representative, which demonstrates that all of Division 26 systems are operational

3.4 OWNER INSTRUCTION AND ASSISTANCE:

- A. At substantial job completion job observation, instruct the Owner's operating personnel in the operation, sequencing, maintenance, and safety/emergency provisions of the electrical systems

3.5 AS-BUILT DRAWINGS:

- A. Record on one set of drawings all changes, deviations and underground conduits. Deliver same to architect/engineer at the conclusion of the project.

END OF SECTION

SECTION 26 05 03 - MOTOR AND EQUIPMENT CONNECTIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Description:

1. Provide power wiring to each motor, all mechanical equipment, all kitchen equipment, and all miscellaneous equipment included in the contract documents. Power wiring is the system of conductors from the energy source to the equipment that conducts the electrical energy which does work or provides heat
2. Provide a disconnect switch, fused where prescribed, for each motor or piece of equipment

B. Related Sections:

1. Section 26 05 00: Electrical General

PART 2 - PRODUCTS

2.1 STARTERS:

- A. Provided under other divisions except where specifically prescribed in Division 26 documents.

2.2 MOTORS AND EQUIPMENT:

- A. Motors, mechanical equipment, kitchen equipment, etc., provided under other divisions.

2.3 CONTROL AND INTERLOCK WIRING:

- A. Control wiring, (i.e., HVAC controls, remote pushbutton stations, thermostats, etc.), is excluded except where specifically prescribed in Division 26 documents

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Coordinate all rough-in and final power wiring and equipment connection with other subcontractors
- B. Install and connect individually mounted starters provided by other subcontractors

- C. Label each disconnect switch and starter with name of equipment it serves.
- D. Coordinate overcurrent device rating with nameplate or motor or equipment

END OF SECTION

SECTION 26 05 13 – CONDUCTORS

PART 1 - GENERAL

1.1 SUMMARY

A. Description:

1. Provide continuous color coded conductors beginning at service point to distribution equipment and to each outlet and each piece of electrical energy consuming equipment

B. Related Sections:

1. Section 26 05 00: Electrical General

1.2 SUBMITTALS:

- A. Manufacturers Product Data Sheets

PART 2 - PRODUCTS

2.1 CONDUCTORS:

A. Copper Conductors:

1. Soft drawn annealed copper, 98% conductivity, without weld, splice or joint throughout its length; uniform in cross section without flaws, scales, or other imperfections with THHN/THWN or XHHW insulation
2. Acceptable Manufacturers:
 - a. Anaconda
 - b. Phelps Dodge
 - c. Pirelli Cable
 - d. Senator
 - e. Southwire
 - f. Triangle

B. Aluminum Conductors:

1. Soft drawn, compacted construction, XHHW insulation, 250 kcmil and larger
2. Acceptable Products:
 - a. Alcan "STABILOY"
 - b. Pirelli "XLPE"
 - c. Southwire

C. Configuration:

1. No. 10 and smaller: Solid
2. No. 8 and larger: Stranded

D. Insulation – 600 Volts:

1. No. 6 and smaller: THHN, THWN

2. No. 4 and larger: XHHW

E. Jacket Color:

1. No. 8 and smaller: Uniform colored jacket
2. No. 6 and larger: Black

F. Jacket Markings:

1. Voltage
2. Insulation type
3. Conductor size
4. Conductor type

2.2 COLOR CODING TAPE:

- A. Vinyl 3/4" wide with uniform color and adhesive backing

B. Acceptable Manufacturers:

1. Brady
2. 3M
3. Plymouth
4. Thomas & Betts

2.3 SPLICE AND TAP MATERIALS:

A. No. 10 and smaller:

1. Crimp type: Cylindrically shaped conductor sleeve for crimping copper conductors. Insulated with nylon or plastic cover
2. Twist on: Inner spiral spring or threads for holding and making electrical contact between copper conductors and with outer long skirted insulated cover of nylon or plastic.

B. No. 8 and larger

1. Set-screw or bolted type: Metal connector for joining copper to copper, with bolts or set-screws to apply pressure to conductors. Insulate with nylon or plastic cover or with electrical tape
2. Pressure type: Metal connectors for joining copper to copper, copper to aluminum, or aluminum to aluminum with power operated crimping tool. Insulate with nylon or plastic cover or with electrical tape

C. Acceptable Manufacturers:

1. AMP
2. Burndy
3. Ideal
4. Ilsco
5. Panduit
6. 3M
7. Thomas & Betts

2.4 CONDUCTOR TERMINALS:

- A. Copper conductors: High conductivity copper terminals designed to hold conductor and make electrical contact by bolt, setscrew or power crimp and with spade to match equipment receiving conductor
- B. Aluminum conductors: High conductivity terminal designed to hold aluminum conductor and make electrical contact by crimping and with spade to match equipment receiving conductor in physical shape, physical size and material
- C. Acceptable Manufacturers:
 - 1. Burndy
 - 2. Ideal
 - 3. Ilsco
 - 4. Panduit
 - 5. Thomas & Betts

2.5 CONDUCTOR HARNESS:

- A. Plastic or nylon self-locking straps (commonly referred to as zip-ties or tie-wraps)
- B. Acceptable Manufacturers:
 - 1. Panduit
 - 2. Thomas & Betts

2.6 WIRE PULLING LUBRICANTS:

- A. Lubricating, insulating and chemically neutral to conductors, conductor insulation and conduits
- B. Acceptable Manufacturers:
 - 1. Greenlee
 - 2. Ideal
 - 3. Polywater

2.7 ELECTRICAL TAPE:

- A. Vinyl plastic; moisture tight, resistant to ultraviolet radiation, alkalis, acids and corrosion; chemically neutral to conductors and conductor insulation; fire retardant; and single thickness dielectric strength equal to or greater than 10,000V
- B. Acceptable Manufacturers:
 - 1. Scotch, 3M
 - 2. Plymouth

2.8 ALUMINUM OXIDE INHIBITING COMPOUND:

- A. Compound shall inhibit the formation of aluminum oxide on clean aluminum conductors without deteriorating the conductors

- B. Acceptable Manufacturers:
1. Burndy
 2. Thomas & Betts

END OF SECTION

SECTION 26 05 26 - GROUNDING

PART 1 - GENERAL

1.1 SUMMARY

A. Description:

1. Provide a grounding system for each feeder, separately derived system, panelboard, and radiating to every electrical power controlling and consuming device in the system

B. Related sections:

1. Section 26 05 00: Electrical General
2. Section 26 05 33: Raceways
3. Section 26 05 13: Conductors

1.2 SUBMITTALS:

- A. Manufacturers Product Data Sheets

PART 2 - PRODUCTS

2.1 GROUND CLAMPS:

- A. Bronze, UL listed, with configuration to match application

B. Acceptable Manufacturers:

1. Burndy
2. IlSCO
3. Thomas & Betts
4. O.Z. Gedney

PART 3 - EXECUTION

3.1 EQUIPMENT GROUNDING CONDUCTOR:

- A. General: Install a separate insulated copper conductor, color coded green, from respective switchboard or panelboard ground bus to controller and/or device. Provide an additional equipment grounding conductor to insulated grounding receptacles. The isolated ground conductor shall be green with a yellow tracer

3.2 ADDITIONAL EQUIPMENT GROUNDING CONDUCTORS:

- A. Wiring Devices: At both switches and receptacles, provide a grounding jumper from the device to a screw on the device box

3.3 EQUIPMENT GROUNDING CONDUCTOR ROUTING:

- A. Route equipment grounding conductor with respective feeder or branch circuit conductors (within the same conduit)

3.4 CONDUITS:

- A. All grounding electrode conductors, equipment grounding conductors and bonds where not internal to equipment enclosures shall be install in conduit to within 6" of terminating clamp or exothermic weld

END OF SECTION

SECTION 26 05 33 - RACEWAYS

PART 1 - GENERAL

1.1 SUMMARY

A. Description:

1. Provide continuous conduit systems – beginning at the service point, to all distribution equipment and to every outlet and piece of electrical equipment with conduits, couplers, supports, hangers, fittings, bushings and accessories.

B. Related Sections:

1. Section 26 05 00: Electrical General

1.2 SUBMITTALS

- A. Manufacturers' Product Data Sheets.

PART 2 - PRODUCTS

2.1 RIGID STEEL AND INTERMEDIATE METALLIC CONDUIT

A. Conduit:

1. Rigid ferrous steel pipe, hot-dipped galvanized or sherardized with smooth interior.
2. Acceptable Manufacturers:
 - a. Allied
 - b. Triangle
 - c. Wheatland

B. Couplings and Connectors:

1. Couplings:
 - a. Hot-dipped galvanized or sherardized ferrous steel, threaded.
2. Connectors:
 - a. Steel or malleable iron, threaded with throat bushings, lock nuts and, where prescribed, grounding lugs
3. Erickson:
 - a. Malleable iron, concrete tight
4. Acceptable Manufacturers:
 - a. Appleton
 - b. Crouse Hinds
 - c. Steel City
 - d. Thomas & Betts

C. Joint Compound:

1. Anti-seize lubricant with rust and corrosion inhibitors and colloidal copper

2. Acceptable Manufacturers:
 - a. Thomas & Betts

D. Expansion Fittings:

1. Steel with three cap nuts, phenolic bushing, packing ring, metallic copper grounding ring and copper bonding jumper
2. Acceptable Products:
 - a. Crouse Hinds "XJ"
 - b. O. Z. Gedney "AX" or "DX"
 - c. Appleton "XJ"

2.2 ELECTRICAL METALLIC TUBING

A. Conduit:

1. Thin wall ferrous steel tubing, hot-dipped galvanized, smooth interior, square and reamed ends
2. Acceptable Manufacturers:
 - a. Allied
 - b. Wheatland
 - c. Triangle

B. Couplings and Connectors:

1. Couplings:
 - a. Steel, compression type, installed where exposed to moisture
 - b. Steel, setscrew type, when installed indoors
2. Connectors:
 - a. Steel, compression type with nylon insulated bushings, locknuts, and where prescribed, grounding lugs, installed where exposed to moisture
 - b. Steel, setscrew type with nylon insulated bushings, locknuts, and where prescribed, grounding lugs, installed indoors.

C. Expansion Fittings:

1. Steel with three cap nuts, phenolic bushings, packing ring, metallic copper grounding ring and copper bonding jumper.
2. Acceptable Products:
 - a. Crouse Hinds "XJ"
 - b. O.Z. Gedney "AX" or "DX"
 - c. Appleton "XJ"

2.3 RIDGID NONMETALLIC CONDUIT:

A. Conduit:

1. Schedule 40 Polyvinyl Chloride (PVC), resistant to crushing, moisture, low temperature, and corrosive agents in standard trade sizes

B. Couplings and Connectors:

1. Couplings: Schedule 40 PVC
2. Connectors: Schedule 40 PVC

- C. Expansion Fittings:
 - 1. Schedule 40 PVC with grommet inner cylinder and outer sleeve
- D. Joint Cement:
 - 1. PVC solvent
 - 2. Acceptable Manufacturers:
 - a. Carlon
 - b. Wheatland
 - c. Allied

2.4 LIQUIDTIGHT FLEXIBLE CONDUIT:

- A. Conduit:
 - 1. Galvanized steel single strip, interlocked, smooth inside and out, with liquid-tight flexible polyvinyl chloride outer jacket
 - 2. Acceptable Manufacturers:
 - a. Carlon
 - b. Wheatland
 - c. Allied
- B. Fittings:
 - 1. Threaded corrosion-resistant steel or malleable iron with insulated throat bushing, liquid tight, locknuts and external Ground lugs
 - 2. Acceptable Manufacturers:
 - a. Appleton
 - b. O.Z. Gedney
 - c. Thomas & Betts

2.5 FLEXIBLE METAL CONDUIT:

- A. Conduit:
 - 1. Galvanized steel single strip, interlocked, smooth inside and out
 - 2. Acceptable Manufacturers:
 - a. AFC
 - b. Alfex
 - c. General Cable
- B. Fittings:
 - 1. Threaded corrosion-resistant steel or malleable iron with insulated throat bushing and lock nuts
 - 2. Acceptable Manufacturers:
 - a. Appleton
 - b. O.Z. Gedney
 - c. Thomas & Betts

PART 3 - EXECUTION

3.1 APPLICATIONS:

- A. Provide Rigid Metal Conduit or Intermediate Metallic Conduit for service entrance, feeders, in slab on grade, areas where exposed to moisture, exposed on exterior surfaces, and exposed interior from floor to 10'-0" or where exposed to physical abuse.
- B. Provide Electrical Metallic Tubing (EMT) for interior power circuits, branch circuits and system circuits in walls, elevated concrete slabs (those not on grade), plenums, attics or exposed above 10'-0", where not exposed to moisture
- C. Provide Rigid Nonmetallic Conduit for service ground, in slab on grade, in direct contact with earth, exposed in corrosive environments above 10'-0" above floor, or service entrance when encased in concrete
- D. Provide Liquid-tight Flexible Metal Conduit for final connecting link (minimum of 12", maximum of 36") to the following:
 - 1. Plumbing equipment
 - 2. Kitchen equipment
 - 3. Exterior Mechanical equipment
- E. Provide Flexible Metal Conduit for:
 - 1. Final connection link (minimum of 12", maximum of 36") to:
 - a. Motors
 - b. Transformers
 - c. Mechanical equipment
 - 2. Connections between junction boxes and accessible recessed lighting fixtures

3.2 CONDUIT SUPPORT

- A. Intervals: Maximum 10 feet on center and within 3 feet of each outlet box, junction box, cabinet or fitting.
- B. Conduits $\frac{3}{4}$ " and smaller
 - 1. Method
 - a. When single conduit: Attach directly to building structure or suspend with $\frac{1}{4}$ " rod
 - b. When multiple parallel and adjacent conduits and:
 - 1) When horizontal at structure: Attach directly to structure or to support framing attached to structure
 - 2) When horizontal suspended: Attach to support framing, suspended from building structure
 - 3) When vertical: Attach to support framing attached to building structure, wall structure or suspended from building structure
 - 2. Conduit attachment:
 - a. When direct to structure or single conduit suspended: Spring steel friction, spring steel latching or clamped with bolts or screws
 - b. When on support framing: Two section bolted conduit clamp
 - 3. Structural steel attachment
 - a. When single conduit: Spring steel friction, clamp with bolt or bolted
 - b. When hanger rod: Clamp with bolt or bolted

4. Concrete attachment: Steel preformed conduit clamp. Attach clamp with expansion anchor installed in drilled hole or with power fastening anchor designed to meet concrete specification. In either case, design support of 300% or greater of load
5. Wood attachment: Wood screws or bolted with design support of 300% or greater of load

C. For 1" or larger:

1. Method:
 - a. When single conduit: Attach directly to building structure or suspend with threaded rod
 - b. When multiple parallel and adjacent conduits: Attach to support framing attached to building structure, wall structure or suspended from building structure
2. Conduit attachment:
 - a. When single conduit: Bolted Clamp
 - b. When on support framing: Two section bolted conduit clamp
3. Structural steel attachment: Beam clamps with bolted or bolted directly to steel
4. Concrete attachment: Provide preset insert prior to concrete pour or coordinate drill location with Architect. When drilling provide expansion anchors. In either case, maintain design support of 300% or greater of load.
5. Wood attachment: Wood screws or bolted with design support of 300% or greater of load

D. Framing:

1. Attachment, suspension and bearing members capable of supporting 300% of load

3.3 INSTALLATION:

- A. For conduit layout follow, generally, the diagrammatic layout shown on plans. Provide offsets and routing changes to avoid structural, architectural or equipment elements
- B. Provide ½" minimum size conduit
- C. Conceal all conduit except where shown to be exposed. Install conduit concealed above a lay-in ceiling with clearance to allow easy removal of ceiling panels.
- D. Install exposed conduit parallel with or perpendicular to building walls at greatest height possible. Paint exposed conduit two coats of color directed by Architect
- E. Extend homeruns from outlets shown to panel designated. Do not combine homeruns.
- F. Use benders designed for the size and type of conduit. Limit each bend to 90 degrees or less with a radius 10 time conduit diameter or greater for telephone system and 6 times conduit diameter or greater for all other systems
- G. Provide insulated bushings at each end of every conduit run
- H. Provide joint compound on rigid steel conduit and intermediate metallic conduit joints
- I. Provide an Erickson type coupling where two segments of a conduit run must be joined and neither can be rotated

- J. Close all conduit ends during construction with plastic conduit plugs
- K. Install conduit no greater than 1" trade size in concrete slabs. Route conduit between top and bottom reinforcing steel and space parallel runs a minimum of 3" apart
- L. Install conduit above water and steam piping where possible
- M. Maintain grounding of metallic raceways with clean and tight connections. Provide grounding conductor in plastic and flexible conduit
- N. Provide ground lugs on all conduit connectors to service equipment enclosures
- O. Provide grounding wedge lugs or locknuts designed to bite metal on conduit connections to panel cabinet or pull boxes
- P. Seal all conduits which extend from the interior to the exterior of the building to prevent the circulation of air
- Q. Provide a thru wall waterproof seal on each conduit that penetrates a wall at a below grade level
- R. Provide an expansion fitting in each conduit crossing a building expansion joint and locate the fitting at the joint. Also provide expansion fitting in building conduits exceeding 100 feet at intervals of 100 feet
- S. Where liquids are present, form drip loops in liquid-tight flexible conduit to prevent liquid from running into connections
- T. Blow out and swab all conduit clear of trash and water prior to pulling wire
- U. Provide a nylon pull cord in all empty conduits
- V. In mechanical equipment room where a piece of equipment is located more than 2 feet away from walls or columns, serve equipment from underfloor or provide a vertical conduit, minimum 1", attached to floor and ceiling with conductors entering and exiting conduit through conduit bodies
- W. Coordinate conduit supports in precast or cast-in-place concrete prior to pour

3.4 UNDERGROUND INSTALLATION

- A. Where exterior of building bury conduit a minimum of 30" below finished grade
- B. Encase conduit in 3" concrete envelope where it passes under driveway, roadways or entrances to parking lots
- C. When under interior slab on grade seal vapor barrier around conduit penetrations

END OF SECTION

SECTION 26 05 34 – BOXES

PART 1 - GENERAL

1.1 SUMMARY

A. Description:

1. Provide electrical boxes or, where required, conduit bodies for devices, outlets, splice connection points, raceway junction and conductor pulling points complete with supports, covers and accessories

B. Related Sections:

1. Section 26 05 00: Electrical General

C. Standards:

1. Underwriters Laboratories labeled and listed for application specified

1.2 SUBMITTALS:

- A. Manufacturers Product Data Sheets

PART 2 - PRODUCTS

2.1 INTERIOR OUTLET BOXES AND EXTENSIONS:

- A. Galvanized steel, UL listed for application with conduit knockouts and threaded holes for mounting devices and/or coverplates:

B. Minimum Sizes:

- a. Single Device: 3”Hx2”Wx2”D
- b. Gang Device: 3”Hx2”W(per gang)x2”D
- c. Octagonal: 4”Wx1-1/2”D
- d. Square: 4” Squarex1-1/2”D

C. Acceptable Manufacturers:

1. Appleton
2. Raco
3. Steel City
4. American Electric

2.2 CONCRETE BOXES

- A. Galvanized steel for encasing in concrete with conduit knockouts and threaded holes for mounting devices and/or coverplates

B. Acceptable Manufacturers:

1. Appleton
2. Crouse Hinds
3. Raco
4. Steel City

2.3 MASONRY BOXES:

- A. Galvanized steel for mounting in masonry walls with conduit knockouts and threaded holes for mounting devices and/or coverplates
- B. Acceptable Manufacturers:
 1. Appleton
 2. Crouse Hinds
 3. Raco
 4. Steel City

2.4 CAST BOXES:

- A. Cast malleable iron, cadmium/zinc plated finish, NEMA 3R, threaded conduit entries, neoprene coverplates gasket and threaded holes for mounting devices and/or coverplates
- B. Acceptable Manufacturers:
 1. Appleton
 2. Crouse Hinds
 3. Raco
 4. Steel City

2.5 JUNCTION AND PULL BOXES:

- A. Dry Locations: Galvanized sheet steel, NEMA 1, welded seams and cover held by stainless steel screws or bolts
- B. Damp or Wet Locations: Cast malleable iron with corrosion-resistant finish, NEMA 3R, threaded conduit entries, neoprene coverplate gasket, and coverplate held by stainless steel bolts
- C. Acceptable Manufacturers:
 1. Appleton
 2. Crouse Hinds
 3. Raco
 4. Steel City

2.6 FLOOR BOXES:

- A. As specified on the drawings for a particular application

PART 3 - EXECUTION

3.1 DEVICE APPLICATIONS

- A. Boxes for switches, receptacles, dimmers (designed for device box mounting) and future devices:
1. For dry locations:
 - a. When recessed:
 - 1) For construction other than concrete or masonry, use interior outlet box
 - 2) For concrete: Concrete box
 - 3) For masonry: Masonry box or square interior box with masonry extension
 - b. When surface: Cast box
 2. For damp or wet locations:
 - a. When recessed:
 - 1) For concrete: Concrete box
 - 2) For masonry: Masonry box or square interior box with masonry extension
 - b. When surface: Cast box
 3. For hazardous areas: Hazardous area boxes

3.2 GENERAL APPLICATIONS

- A. For lighting fixtures, equipment connections, pullboxes for conduit 1" and smaller, and junction boxes for conduits 1" and smaller
1. Recessed Interior Box:
 - a. For construction other than concrete or masonry, use octagonal or square interior outlet box
 - b. For concrete: Concrete box
 - c. For masonry: Concrete box or square interior box with masonry extension
 2. Box above an accessible ceiling: Octagonal or square interior outlet box
 3. Exposed interior box:
 - a. Above 7'-0": Octagonal or square interior outlet box or conduit body
 - b. 7'-0" and below: Cast box or conduit body
 4. Exterior Box:
 - a. When recessed in vertical element or ceiling:
 - 1) For concrete: Concrete box
 - 2) For masonry: Concrete box or square interior box with masonry extension
 - 3) For construction other than concrete or masonry, provide square interior box
 - b. Flush mounted in ground: Cast junction box
 - c. Exposed: Cast box or conduit body
- B. Hazardous Locations: Hazardous are box
- C. Integrally Mounted Boxes: Boxes which are an integral part of an equipment assembly from the manufacturer and UL listed for the application may be used in lieu of the boxes prescribed above

3.3 JUNCTION BOXES AND PULL BOXES (conduit larger than 1"):

- A. Junction boxes re conduit bodies where junction is exposed

3.4 SUPPORT

- A. General: Support each box from the building structure independently of conduit as follows, utilizing a support system capable of carrying 300% of load
 - 1. Surface:
 - a. Structural steel: Bolted directly to steel member or bolted to spring clip which is clipped to steel member
 - b. Concrete: Power driven fastener or bolt to expansion anchor set in drilled hole
 - c. Wood: Screw or bolt to wood
 - 2. Suspended: Bolted to engineered spring clip which is clipped to suspended ceiling system
 - 3. Recessed:
 - a. Concrete: Set in concrete prior to pour
 - b. Masonry: Set or cut into masonry during masonry erection. Grout in around box
 - c. Drywall: Attach directly to stud or joist by screw or bolt; or directly to a galvanized steel support which is attached directly at each end to stud or joist by screw or bolt
 - d. Earth: Compact earth around box.

3.5 INSTALLATION:

- A. Outlet locations indicated on the plans are approximate. Coordinate and determine the exact location at the building. The architect reserves the right to shift the exact location of any outlet 10 feet before it is permanently installed
- B. Install boxes plumb when vertical, level when horizontal and flush adjacent surface when recessed
- C. Where an outlet occurs in an architectural feature, center the outlet in same
- D. Where the mounting height of a wall outlet is not shown, mount at height directed by Architect. Mounting heights are from finished floor to box centerline
- E. The contractor may, with Architect's approval, slightly vary an outlet's mounting height so that the box's top or bottom occurs at a masonry joint
- F. Where outlets at different levels are shown adjacent, install them on the same vertical line
- G. Space wall switch outlets with the first gang box 4" from door trim on the installed strike side
- H. Locate boxes and conduit bodies so that covers are accessible and removable
- I. Limit masonry cuts from outlet boxes so that coverplate covers the cut
- J. Provide plaster rings for all boxes set in plaster walls or ceilings
- K. Match configuration to application

- L. Utilize box size (capacity) based upon NEC
- M. For devices, utilized boxes designed to support the device independently of coverplate and so install
- N. Cover unused conduit openings with metal covers for sheet steel boxes and threaded plugs for cast boxes
- O. Prior to pulling conductors or installing devices, clean boxes of dirt, debris and water
- P. Cover all boxes and secure with screws or bolts
- Q. Install pull boxes to limit pulling distance and/or pulling bends

END OF SECTION

SECTION 26 05 53 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 Summary:

A. Description:

1. Identify the following electrical equipment with a nameplate or directory indicating load served or equipment name:
 - a. Panelboards, Main and Branch Breakers
 - b. Disconnect Switches and Motor Starters
 - c. Contactors, Time Switches and Relays

1.2 Submittals:

- A. Sample of Nameplate

PART 2 - PRODUCTS

2.1 Nameplates:

- A. 120 Volts, 208 Volts, and 240 Volts – Bakelite label, black face, white core
- B. 277 Volts and 480 Volts – Bakelite label, red face, white core
- C. Lettering:
1. Main Service Disconnect – ½” high letters
 2. All others – ¼” high letters

2.2 Panelboard directory:

- A. Panelboard manufacturers directory in plastic sleeve on inside of panel cover door

PART 3 - EXECUTION

3.1 Installation:

- A. Securely mount each nameplate to its respective equipment with screws or epoxy type cement. Double sided foam core type tape is not acceptable
- B. Type in the branch breaker load information onto the manufacturers’ panel directory. Mark all spares in pencil. Install in plastic sleeve on inside of panel cover door

- C. Label all junction box covers with the circuit number installed in the box with a permanent marker

END OF SECTION

SECTION 26 28 19 - DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Description

1. Provide disconnect switches in configurations as indicated on the drawings complete with enclosures and accessories

B. Related Sections

1. Section 26 05 00: Electrical General
2. Section 26 05 03: Motor and Equipment Connections

1.2 SUBMITTALS

- A. Manufacturers Product Data Sheets

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable manufacturers as follows:

1. General Electric
2. Siemens/ITE
3. Square D
4. Cutler Hammer

2.2 DISCONNECT SWITCHES:

- A. Disconnect switches shall be heavy duty (NEMA Type HD) and Underwriters Laboratories Listed
- B. All switches shall have blades which are fully visible in the "OFF" position when the switch door is open. All current carrying parts shall be plated to resist corrosion and promote cool operation. Switches shall have removable arc suppressors where necessary to permit easy access to the line side lugs. Lugs shall be front removable and UL listed for 60 degrees C or 75 degrees C, aluminum or copper wires
- C. Switches shall be quick-make, quick-break such that, during normal operation of the switch, the operation of the contacts shall not be capable of being restrained by the operation handle after the closing or opening action of the contacts has started. The operating handle shall be an integral part of the box, not the cover. Provisions for padlocking the switch in the "OFF" position with at least three locks shall be provided. Switches shall have a dual cover interlock to prevent unauthorized opening of the switch door when the handle is in the "ON" position,

and to prevent closing of the switch mechanism with the door open. The handle position shall indicate whether the switch is "ON" or "OFF"

- D. Switches shall be furnished in NEMA 1 general purpose enclosures unless specified as NEMA 3R on the plans. Covers on NEMA 1 enclosures shall be attached with pin type hinges, NEMA 3R covers shall be securable in the open position. NEMA 3R enclosures for switches thru 200 amperes shall have provisions for interchangeable bolt-on hubs. Hubs shall be as indicated on the plans. NEMA 3R enclosures shall be manufactured from galvanized steel. Enclosures shall have a gray baked enamel finish, electrodeposited on cleaned, phosphatize steel
- E. Switches shall be horsepower rated for as and/or dc as indicated by the plans. All fusible switches rated 100 thru 600 amperes at 240 volts and 30 thru 600 amperes at 600 volts shall have a UL approved method of field conversion from standard Class H fuse spacing to Class J fuse spacing. The switch also must accept Class R fuses and have provisions for field installation of UL listed rejection scheme. The UP listed short circuit rating of the switch, when equipped with Class H fuses, shall be 10,000 rms symmetrical amperes. 800 and 1200 ampere switches shall have provisions for Class L fuses and shall have a UP listed short circuit rating of 200,000 rms symmetrical amperes

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install disconnect switch adjacent to equipment it serves or as located on the plans
- B. Anchor enclosures firmly to wall and/or structural surfaces. Coordinate mounting of disconnect to roof top mechanical equipment with supplier/installer

END OF SECTION