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<p style="text-align: center;">SECTION 23 05 00 COMMON WORK RESULTS FOR HVAC</p> <p><b>1.0 GENERAL</b></p> <p><b>1.01 DESCRIPTION</b></p> <p>A. This Division 23 and the accompanying drawings cover the provision of all labor, equipment, appliances, and materials and performing all operations in connection with the construction of the air conditioning, ventilating, heating, fire suppression and plumbing systems as specified herein and as shown.</p> <p>B. The General Provisions and Division 01, including the general, supplementary and other conditions and other Divisions, as appropriate, apply to work specified in this Division.</p> <p><b>1.02 EXISTING CONDITIONS</b></p> <p>A. Attention is called to the fact that the work is to be performed within an existing, operational facility. Prior to the submission of bids, each bidder shall visit the project site, thoroughly investigate and be familiar with all existing conditions which will affect their work, especially the work to be performed above the existing ceilings.</p> <p>B. Connect new work to existing work in a neat and workmanlike manner. Where an existing structure must be cut or existing utilities interfere, such obstructions shall be bypassed, removed, replaced or relocated, patched and repaired. Work disturbed or damaged shall be replaced or repaired to its prior condition.</p> <p><b>1.03 INTENT OF DRAWINGS AND SPECIFICATIONS</b></p> <p>A. The implied and stated intent of the drawings and specifications is to establish minimum acceptable standards for materials, equipment and workmanship, and to provide operable mechanical systems complete in every respect.</p> <p>B. The engineering drawings are diagrammatic, intended to show general arrangement and sizes of system components, and shall not be scaled. Rather, the architectural and structural drawings shall govern space constraints, dimensions and finishes. All offsets and fittings which will be necessary to accomplish the finished installation shall be provided at no additional cost or increase in the Contract.</p> <p><b>1.04 SPACE PRIORITY</b></p> <p>A. Ensure optimum use of available space for materials and equipment installed above ceilings. Allocate space in the order of priority as listed below except as otherwise detailed. Items are listed in the order of priority, with items of equal importance listed under a single priority number.</p> <ol style="list-style-type: none"> <li>Gravity flow piping systems</li> <li>Vent piping systems</li> <li>Recessed lighting fixtures</li> <li>Concealed HVAC terminals and equipment</li> <li>Air duct systems</li> <li>Sprinkler piping systems</li> <li>Pressurized piping systems</li> <li>Electrical conduit, wiring, control air tubing</li> </ol> <p>B. Order of space priority does not dictate installation sequence. Installation sequence shall be as required to install all affected trades.</p> <p>C. The work of this Division 23 shall not obstruct access for installation, operation and maintenance of the work of any other Division.</p> <p>D. All major items of equipment shall be arranged so as to provide a minimum of 28" clear aisle space. Additional space shall be provided between and around equipment for maintenance and proper operation as shown in the Equipment Manufacturer's literature.</p> <p><b>1.05 COORDINATION</b></p> <p>A. Coordinate all work under this Division 23 with work under all other Divisions, providing adjustment as necessary.</p> <p>B. Coordination of space requirements with respect to Division 26 shall be performed such that:</p> <ol style="list-style-type: none"> <li>No equipment, piping or ductwork, other than electrical, shall be installed within 42" of switchboards or panelboards.</li> <li>No piping or ductwork which ever operates at a temperature in excess of 120°F shall be installed within 3" of any electrical conductor.</li> </ol> <p>C. All items mounted in or below the ceiling, and all items penetrating the ceiling, shall be coordinated with the architectural reflected ceiling plans. If any items are not shown on these plans, or any items need to be relocated for coordination purposes, prepare a reflected ceiling plan and submit it to the Architect for approval.</p> <p>D. Variable-Frequency Drives shall be provided under Division 23 and installed by Division 26. See specification 26 29 23 Variable - Frequency Motor Controllers.</p> <p>E. Fused disconnects shall be provided under this Division 23 for all equipment connected directly to bus duct, and rating shall match bus duct rating. Coordinate with Division 26.</p> <p><b>1.06 CODE COMPLIANCE</b></p> <p>A. All workmanship and materials provided under this Division 23 shall comply with all laws, ordinances, codes and regulations of all Federal, State and Local Authorities Having Jurisdiction.</p> <p>B. All fire suppression, plumbing, heating, ventilating, and air conditioning materials and workmanship shall comply with the following codes and standards as minimum requirements:</p> <ol style="list-style-type: none"> <li>NFPA 70, National Electrical Code, 2017 Edition</li> <li>Life Safety Code (NFPA 101) - 2015 Edition</li> <li>All other NFPA Codes and Standards - Applicable Editions</li> <li>North Carolina State Building Code - 2018 Edition</li> <li>North Carolina State Energy Code - 2018 Edition</li> <li>North Carolina State Fire Prevention Code - 2018 Edition</li> <li>North Carolina State Mechanical Code - 2018 Edition</li> <li>North Carolina State Plumbing Code - 2018 Edition</li> <li>North Carolina Accessibility Code - 2018 Edition</li> <li>American with Disabilities Act, January 26, 1992</li> <li>American National Standard Handicapped Code, A117.1 - 1986 Edition</li> <li>ASME A17.1 Safety Code Elevators and Escalators, 2013 Edition</li> </ol> <p>C. Secure and pay all fees associated with all permits and licenses required for execution of the Contract. Arrange for all inspections required by City, County, State and other Authorities Having Jurisdiction, and deliver certificates of approval to the Architect.</p> <p>D. The code requirements are strictly a minimum and shall be met without incurring additions to the Contract. Where requirements of the drawings or specifications exceed the code requirements, the work shall be provided in accordance with these drawings or specifications. In the event of conflict or ambiguity between the various codes, the most stringent requirement shall govern.</p> <p><b>1.07 ELECTRICAL REQUIREMENTS AND INTERFACE</b></p> <p>A. All electrical equipment and wiring provided under this Division 23 shall comply with the electrical system characteristics indicated on the electrical drawings and specified in Division 26.</p>	<p>B. Electric controls, contactors, starters, pilot lights, push buttons, etc., shall be provided complete as part of the motor, heater or other equipment which it operates. All electrical components shall be in conformance with the requirements of the National Electrical Code and Division 26. Starters shall be wye-delta, closed transition type. Reference Division 26 and the electrical engineering drawings for these motor starters provided under this Division 26. All starters not shown shall be provided under this Division 23. Unless specified otherwise under other individual equipment Sections, motor starters shall conform to the following minimum requirements:</p> <ol style="list-style-type: none"> <li>Starters for motors 1/3 horsepower or smaller shall be manual unless remote or automatic starting is required, in which case the starters shall be magnetic, full voltage, non-reversing, single-speed, unless otherwise indicated. All other starters shall be magnetic.</li> <li>Each starter for a three-phase motor shall be furnished with three (3) overload relays sized for the full load running current of the motor actually provided. Provide an external "HAND-OFF-AUTO" selector switch with red "RUNNING" light. Provide a green pilot light to indicate motor "STOPPED". Each pilot light shall have a legend plate indicating reason for signal.</li> <li>Each overload relay shall have a normally open alarm contact which will close only when actuated by an overload (not to be confused with N.O. or N.C. auxiliary contacts). These contacts shall be properly wired to their respective blue pilot light provided on the starter front cover and having a "TRIPPED" legend plate.</li> <li>Individually mounted motor starters shall be in a NEMA Type 1 general purpose enclosure in unfinished areas and shall be flush mounted in all finished areas. All starters mounted in exterior areas shall have a NEMA 3R enclosure. Each starter shall have a laminated nameplate to indicate equipment unit number, function and circuit number.</li> <li>All motor starters, push buttons and pilot lights shall be of the same Manufacturer as the switchboard and shall be General Electric, Square D, Siemens I.T.E., or Westinghouse.</li> </ol> <p>C. Motor starters for the following equipment shall be provided under this Division 23 by the Manufacturer of the equipment:</p> <ol style="list-style-type: none"> <li>Packaged air conditioning equipment</li> <li>Water chillers</li> <li>Other equipment hereinafter specified in other Sections to be provided with integral starters</li> </ol> <p>D. Unless otherwise noted or specified in individual Sections, all 3-phase motors shall be standard NEMA continuous duty "B" type, with Class B insulation, open drip-proof frame for indoor service, TEFC for outdoor service and a service factor of 1.15. All motors 5 HP and larger shall be U.S. Motors Hi-Efficiency Model or Reliance KE Hi-Efficiency Model.</p> <p>E. All power wiring and final connections to equipment shall be provided under Division 26.</p> <p>F. Control components, all interlocks, (VAVs, actuators, smoke dampers, fire/smoke dampers, motor-operated dampers, fire alarm motors, etc.) and control wiring (277 volt, single phase and less) shall be provided under this Division 23 as required to achieve the specified control sequences. All electrical connections shall be specifically coordinated with Division 26 and any necessary scope included as part of Division 23.</p> <p>G. All control wiring over 30 volts shall be installed by a licensed Electrician working under this Division 23.</p> <p><b>1.08 SLEEVES, SEALS AND ESCUTCHEONS</b></p> <p>A. Sleeves shall be provided through all pipe and ductwork penetrations of concrete or masonry walls, elevated floors and roofs, except those piping penetrations for equipment, etc.</p> <p>B. Sleeves shall be fabricated from Schedule 40 steel pipe through 10" and Standard Wall steel pipe for sleeve sizes 12" and larger. All sleeves penetrating exterior walls, underground walls, pit or vault walls shall be provided with a 3" x 3/8" thick waterstop ring welded completely to the midpoint of the sleeve.</p> <p>C. All sleeves penetrating exterior walls, underground walls, pit or vault walls and elevated floors shall be packed and sealed watertight.</p> <p>D. Sleeves through roofs shall extend above the roof surface and be flashed watertight.</p> <p>E. Sleeves through walls shall be cut and finished flush with each surface of the wall in which they are installed.</p> <p>F. Sleeves through floors in mechanical rooms or other back of house spaces shall be installed with the top no less than 1/2" above the finished floor to allow for leak protection. Space between the top of the fire-stopping and top of the sleeve shall be packed with mineral wool and caulked to not allow water ponding within the sleeve.</p> <p>G. Sleeves shall be sized to provide a minimum of 1/2" clearance between the inside surface of the sleeve and the outside finished surface of the pipe plus any insulation specified.</p> <p>H. Fire-stops shall be provided as specified herein. All annular spaces between piping and sleeves, which do not require fire-stops, shall be packed with mineral wool and caulked.</p> <p>I. Provide round, chrome-plated escutcheons on all exposed piping and ductwork penetrations passing through walls, floors, partitions and ceilings. Escutcheons shall be painted and caulked in coordination with Architect. Note that escutcheons should be only attached to the wall as piping and ductwork may move slightly during operation.</p> <p><b>1.09 FIRESTOPS</b></p> <p>A. Where piping, conduit, etc. pass through fire partitions, fire walls and floors, a firestop shall be provided that will create an effective barrier against the spread of fire, smoke and gases. Firestop material shall be packed tight and completely fill gaps between the ductwork, piping, conduit, etc. and the perimeter of their rough openings.</p> <p>B. All penetrations shall be in accordance with UL 1479 or ASTM E 814 listed systems, and products used shall be specifically applicable for the appropriate installation conditions. Assemblies shall provide a minimum rating equal to the construction penetrated. Products shall be by HILTI, 3M, or ProSet.</p> <p>C. Installation shall be by a Qualified Installer. Installer shall be certified, licensed, or otherwise qualified by the Firestopping Manufacturer as having the necessary training to install the Manufacturer's specific product. A Manufacturer or Vendor's willingness to sell the firestopping product to the Contractor or Installer does not in itself confer qualification.</p> <p>D. Installer shall have at least one of the following qualifications:</p> <ol style="list-style-type: none"> <li>FM 4991 Approved Contractor</li> <li>UL Approved Contractor</li> <li>HILTI, 3M, or ProSet Accredited Fire Stop Specialty Contractor</li> </ol> <p>E. Installing Firm shall have no less than 3 years of experience with firestop installation.</p> <p>F. A Manufacturer's direct Representative (not Distributor or Agent) shall be on site during initial installation of firestop systems to train appropriate Contractor personnel in proper selection and installation procedures.</p> <p>G. The firestop Contractor or Installer shall supply As-Built documentation of each individual penetration location on the project. Documentation shall include a sequential location number, detailed description of the penetration location, size, and type, tested system number, type of assembly penetrated, and rating to be achieved. As-Built documentation shall be included with the close-out materials.</p> <p>H. Identify through-penetration firestop systems with pressure-sensitive, self-adhesive, preprinted vinyl labels. Attach label permanently on both sides of penetrated construction in a visible location. The label shall include the following:</p> <ol style="list-style-type: none"> <li>The words "Warning - Through Penetration Firestop System-Do Not Disturb"</li> <li>Through Penetration firestop system designation and Manufacturer</li> <li>Date of installation</li> </ol>	<p><b>1.10 CORE DRILLING</b></p> <p>A. Cutting of holes through concrete and masonry shall be by diamond core or concrete saw. Pneumatic hammer, impact electric and hand or manual hammer type drills will not be allowed, except as permitted by the Architect where required by limited working space. Locate holes such that they will not affect structural sections such as ribs or beams. Holes shall be laid out well in advance of the installation. These layout locations shall be approved by the Architect prior to drilling.</p> <p><b>1.11 IDENTIFICATION OF PIPING</b></p> <p>A. All aboveground HVAC piping sized 3/4" and larger which is installed in accessible locations (including piping above removable ceilings and behind access panels) shall be identified in strict conformance with the "Scheme for the Identification of Piping Systems" (ANSI A13.1-2015).</p> <p>B. Piping labels in exposed areas shall be oriented and located in coordination with the Architect.</p> <p>C. Specific system names shall be subject to Owner approval. System names shall, at minimum, uniquely identify the system and performance category - i.e. Base Building Condenser Water Supply, Cooling Tower Make-up, etc.</p> <p>D. Each identification marker shall include to the following:</p> <ol style="list-style-type: none"> <li>Proper color-coded background</li> <li>Proper color of legend in relation to background color</li> <li>Proper legend letter size</li> <li>Proper marker length</li> <li>Direction of flow arrows shall be included on each marker</li> </ol> <p>E. Locations for pipe markers shall be as follows:</p> <ol style="list-style-type: none"> <li>Adjacent to each valve and fitting</li> <li>At each branch and riser take off</li> <li>At each pipe passage through walls, floors or ceilings</li> <li>On all straight pipe runs every 25 feet</li> </ol> <p>F. Identification markers may be stenciled or shall be Setmark Pipe Markers, as manufactured by Seton Name Plate Corporation.</p> <p>G. All valves shall be identified with the appropriate service designation and valve number with brass valve tags. Each valve tag shall be 19 gauge brass with 1/4" black-filled letters over 1/2" black-filled numbers. Tags shall be fastened to valves with brass "S" hooks or brass jack chain. Brass tags and fasteners shall be as manufactured by Seton Name Plate Corporation.</p> <p>H. Provide charts of all valves. Valve charts shall include the following items:</p> <ol style="list-style-type: none"> <li>Valve identification Number</li> <li>Location</li> <li>Purpose/Manual</li> </ol> <p><b>2.0 PRODUCTS</b></p> <p><b>2.01 BID BASIS AND SUBSTITUTION PROCEDURES</b></p> <p>A. Manufacturer names, series and model numbers, as noted or specified, are for the purpose of describing type, capacity, and quality of equipment, materials and products to be used. Unless "or equal" is specifically stated, bids shall be based only on the specified "basis of design" Manufacturer. The listing of a particular manufacturer as an "equal" or "acceptable substitute" manufacturer shall not be misconstrued as approving nor allowing the substitution of that Manufacturer's standard product in place of the basis of design. No consideration will be given to a product, which would require dimensional, spatial or aesthetic changes to the project. "Acceptable substitute" and "equal" manufacturers shall only bid those products, which exactly match the size and other characteristics of the specified basis of design. Any changes to other disciplines and trades of work required by an "or equal" or "substitute" product shall be fully considered and priced accordingly prior to bidding or pricing. The decision as to whether or not a proposed substitute or "equal" product is actually equal to that specified shall rest solely with the Architect.</p> <p>B. Requests to provide "equal" products in lieu of those specified shall be submitted to the Architect in writing at least ten (10) days prior to final pricing and execution of the Contract. No consideration will be given to substitute products after final pricing and execution of the Contract.</p> <p>C. Any "or equal" product or proposed product substitution which will cause a change in the appearance, dimensions or design of any part of the building, its structure, electrical system or any other engineered systems shall be accompanied by a scaled drawing and written description of the required change(s) for approval by the Architect. If deemed necessary by the Architect, Owner, or A/E, design changes shall be signed and sealed by a registered Professional Engineer, currently licensed in this State. This shall be performed under the Contractor's scope who selects the substitution.</p> <p>D. Any and all changes due to a substitution of basis of design equipment including but not limited to electrical connection, physical size, access, duct or piping connections, controls, etc. shall be solely the responsibility of substituting Contractor.</p> <p><b>2.02 MINIMUM STANDARDS</b></p> <p>A. Every piece of energy consuming equipment, all fire suppression products and life safety equipment shall comply with the following standards as applicable; especially in regard to prevailing codes:</p> <ol style="list-style-type: none"> <li>Factory Mutual Laboratories (FM)</li> <li>Industrial Risk Insurers (IRI)</li> <li>Underwriters Laboratories, Inc. (UL)</li> <li>ADC: Air Diffusion Council</li> <li>AGA: American Gas Association</li> <li>AMCA: Air Moving and Conditioning Association, Inc.</li> <li>ANSI: American National Standards Institute</li> <li>API: American Petroleum Institute</li> <li>AHRI: Air Conditioning, Heating, and Refrigeration Institute</li> <li>ASHRAE: American Society of Heating, Refrigerating and Air Conditioning Engineers</li> <li>ASME: American Society of Mechanical Engineers</li> <li>ASTM: American Society of Testing and Materials</li> <li>AWWA: American Water Works Association</li> <li>IBR: Institute of Boiler and Radiator Manufacturers</li> <li>MSMS: Manufacturers Standardization Society</li> <li>NBBPV: National Board of Boiler and Pressure Vessel Inspectors</li> <li>NEMA: National Electrical Manufacturer's Association</li> <li>OSHA: Occupational Safety &amp; Health Administration</li> <li>PDI: Plumbing Drainage Institute</li> <li>PPi: Plastic Pipe Institute</li> <li>SMACNA: Sheet Metal and Air Conditioning Contractors National Association, Inc.</li> </ol> <p><b>2.03 PIPE HANGERS AND SUPPORTS</b></p> <p>A. Pipe hangers, trapeze hangers, upper attachments, rods and other supports shall be selected based on pipe size and material contained therein. Provide all hangers, rods, turnbuckles, angles, channels and other supports to securely support the piping systems from the building structure.</p>	<p>B. All materials utilized for the hanging and support of the piping systems shall be manufactured products, which are specifically intended for the purpose of hanging piping systems. The use of wire, steel straps, plastic ties, etc. is strictly prohibited.</p> <p>C. Supports and hangers shall be selected to fit around the pipe (and insulation unless otherwise specified herein) and provide adequate movement for expansion of the piping systems. Anchors shall be provided to restrict and control such movement within offsets and expansion loops.</p> <p>D. All hangers and supports shall be selected at a minimum factor of safety of five based on the ultimate tensile strength of the material.</p> <p>E. Intermediate pipe supports shall be provided between building structural members so as not to exceed maximum support spacing specified and shall be structural steel angles (minimum 2 1/2" x 2 1/2" x 1/4"). In steel construction, intermediate supports shall be securely clamped to steel beams and to steel joists, and in no case shall supports be attached to roof decks.</p> <p>F. For suspending pipes from concrete beams, upper attachments shall be steel beam bracket utilizing bolts in sleeves set in top portions of the beams. Where sleeves are not used, provide expansion shields or power-actuated fasteners.</p> <p>G. Hanger rods for pipe hangers shall be as follows:</p> <ol style="list-style-type: none"> <li>3/8" hanger rod - 2" nominal pipe and smaller</li> <li>1/2" hanger rod - 2 1/2" and 3" nominal pipe</li> <li>5/8" hanger rod - 4" and 5" nominal pipe</li> <li>3/4" hanger rod - 6" nominal pipe</li> <li>7/8" hanger rod - 8" through 16" nominal pipe</li> </ol> <p>H. Pipe hangers selected for supporting horizontal insulated piping shall be sized to fit around the outside of the pipe insulation except for the following services, which shall be sized to fit around the pipe and under the insulation:</p> <ol style="list-style-type: none"> <li>Hot water supply and return piping, steam, condensate return and related piping sized 2" and smaller.</li> </ol> <p>I. Provide pipe saddles, inserts and shields on all insulated piping as outlined below:</p> <ol style="list-style-type: none"> <li>Hot water supply and return piping and associated steam and condensate return piping over 2" shall be supported by steel saddles welded to pipe. Insulation shall be continuous through the saddle.</li> <li>All other insulated piping shall be supported on Foamglas insulation inserts and galvanized shields, except that no inserts are required on piping sized less than 2". Foamglas inserts shall extend at least 2" past each end of the pipe shields.</li> </ol> <p>a. Shields shall be as follows:</p> <ol style="list-style-type: none"> <li>Pipes 2" and smaller: 18 gauge x 12" long</li> <li>Pipes 2 1/2" and larger: 16 gauge x 18" long</li> </ol> <p>b. Shields and inserts shall be 180 degrees around the lower half of the pipe at all pipe hangers, except that on trapeze hangers, pipe racks and floor supported horizontal pipes, shields shall be 360 degrees around the entire pipe.</p>	<p><b>3.0 EXECUTION</b></p> <p><b>3.01 SUBMITTALS</b></p> <p>A. Before preparing submittals, study all Contract Drawings and specifications in detail, obtain manufacturer's recommended instructions, and have submittals prepared based on specific equipment and material proposed for installation. An officer of the Contracting Firm shall sign all shop drawings (certifying conformance with plans and specifications) before submitting to the Architect or releasing to the field.</p> <p>B. The submittal process shall not be utilized as an avenue to substitute products after the execution of the contract. Should an unspecified or unequal product be submitted, it will be rejected. If a second attempt at substitution is made during the resubmittal of the same product, then no more reviews of that product will be performed without direct compensation to the Engineer being paid for the additional services required for the third review and any further reviews.</p> <p>C. All submittals shall be submitted and returned electronically.</p> <p>D. Submittals will not be accepted for review unless they:</p> <ol style="list-style-type: none"> <li>Comply with the requirements of Division 1</li> <li>Include complete information pertaining to all appearances and accessories</li> <li>Are submitted as complete packages which pertain to all related items in Division 23. Separate packages shall be submitted as follows: <ol style="list-style-type: none"> <li>All HVAC equipment and components</li> <li>The automatic controls and EMS</li> </ol> </li> <li>Are properly marked with equipment, service, or function identification as related to the project and are marked with pertinent specification paragraph number</li> </ol> <p>E. Submit catalog information, factory assembly drawings, field installation drawings and certifications as required for complete explanation and description of all items of equipment. The submittal data shall provide ample, unquestionable compliance with the Contract Documents.</p> <p>F. Review of submittals shall not be construed as authorizing any deviations from the plans and specifications unless such deviations are clearly identified and separately submitted in the form of a letter that is enclosed with the submittals.</p> <p>G. Submittals are required on all manufactured equipment, especially energy consuming equipment. Submittals shall include, but are not limited to, the following items of equipment:</p> <ol style="list-style-type: none"> <li>Ductwork and Piping Insulation</li> <li>Terminal Units</li> <li>Split Systems</li> <li>Packaged Rooftop Units including proposed controller and points list</li> <li>Air Distribution Devices</li> <li>Ductwork Accessories (Including All Dampers)</li> <li>Fans</li> <li>Unit, Wall, Ceiling, Duct, Etc. Heaters</li> <li>T&amp;B Company Certifications and Final Report</li> <li>Ductwork and Piping Shop Drawings</li> </ol> <p><b>3.02 INSTALLATION REQUIREMENTS</b></p> <p>A. All equipment shall be installed in strict conformance with the recommendations of the Equipment Manufacturer, as indicated on the Drawings and as specified.</p> <p>B. Provide installation manuals for each piece of equipment. Submit in separately bound volumes after review of submittals.</p> <p>C. Provide supplementary steel framing and welded steel equipment support stands as required for proper hanging and support of the mechanical systems. Steel angles, channels and tubing utilized for such framing shall be selected for a maximum deflection of 1/360th of the span.</p> <p>D. All roof curbs shall be a minimum of 12" high and selected for the various roof pitches. Curbs installed on roofs having pitches of not more than 1/4" per foot may be standard curb shimmed level with steel channels or Zs to provide suitable support and flashing surfaces.</p> <p><b>3.04 CLEANING, LUBRICATION AND ADJUSTMENT</b></p> <p>A. The exterior surfaces of all mechanical equipment, piping, ductwork, conduit, etc., shall be cleaned and free of all dirt, grease, oil, paint spatter, and other construction debris.</p>	<p>B. Ducts, plenums, and air unit casings shall be cleaned of all debris and either vacuumed or blown free of all rubbish, dirt, and dust before installing grilles, registers or diffusers.</p> <p>C. Bearings that require lubrication shall be lubricated in strict accordance with the manufacturer's recommendations.</p> <p>D. All control equipment shall be adjusted to the settings required for the performance specified.</p> <p>E. Fans shall be adjusted to the speed indicated by the Manufacturer to meet the installed final system pressure at the airflow indicated. Any additional sheaves and belts required for final adjustments shall be provided with no increase in the Contract amount.</p> <p>F. Any fans operated during construction shall have temporary filters. Temporary filters shall be changed regularly to minimize contamination of the equipment and duct systems. Permanent filters shall be installed prior to final inspection.</p> <p>G. All coils shall be thoroughly cleaned and combed prior to final inspection.</p> <p>H. All materials, equipment, etc. subject to weather, corrosion, dust, debris, water etc. to be installed or utilized for the project shall be fully protected. This is inclusive of piping and duct openings and internal fan ventilation intakes and discharges. This Division's scope includes protection and remediation of any and all Division materials, etc. including cleaning, vacuuming, dusting, etc. required for a clean system and operation. Insulation and equipment with electrical connections subject to water shall be replaced in their entirety. Coordinate with all other trades and schedules.</p> <p><b>3.05 PAINTING</b></p> <p>A. All uncoated and uninsulated steel surfaces exposed to sight inside the building, such as piping, equipment hangers and supports which are not provided with factory prime coat or galvanizing, shall be cleaned and painted with one coat of rust inhibiting primer. In addition, all surfaces in finished spaces shall also be painted with two coats of finish paint in a colour selected by the Architect.</p> <p>B. All ductwork surfaces, piping, supports, etc. visible through grilles, registers and diffusers in finished areas shall be painted flat black. All ductwork, equipment, piping, supports, air distribution, etc. visible in exposed finished areas shall be painted a colour selected by the Architect, except that nameplates shall not be painted.</p> <p>C. Steel items exposed outside the building, such as equipment supports, uninsulated piping and hangers, which are not factory painted or galvanized, shall be cleaned and painted with one coat of rust inhibiting primer and two coats of asphaltic base aluminum paint. Insulated steel pipes outside the building shall be cleaned and painted with one coat of rust inhibiting primer before installing insulation.</p> <p>D. Factory painted equipment that has been scratched or marred shall be repainted to match the original factory color.</p> <p><b>3.06 DUCTWORK AND PIPING LEAK TESTING</b></p> <p>A. Insulated, underground, and concealed ductwork and piping shall be tested for leaks in place before backfilling, concealing or covering. Tests shall be conducted in the presence of the Architect or their designated Representative.</p> <p>B. All low pressure ductwork (design operating pressure of 1.0" WC ESP or less) shall be tested by the operation of the system to which it is connected.</p> <p>C. All medium and high pressure ductwork (operating pressure of more than 1.0" WC ESP) shall be tested at 1.5 times the design operating pressure of the system to which it is connected, or at the total fan pressure at shut-off, whichever is greater, up to the maximum pressure classification of the associated ductwork system.</p> <p>D. All visible and audible air leaks from the ductwork systems shall be repaired.</p> <p>E. See specification section 23 11 23 for testing requirements of natural gas **and liquid propane gas piping. System shall be part of Division 22 scope unless otherwise arranged within the Contract. Coordinate with Division 22.</p> <p>F. **Chilled water, condenser water, and hot water supply and return piping shall be hydrostatically tested at a pressure of not less than the greater of 1.5 times the operating pressure or 100 psig, whichever is greater, for a minimum of one hour. No loss in pressure shall be permitted.</p> <p>G. **Steam and condensate return piping shall be tested at a test pressure of 100 psig minimum but not less than 1.25 times the system operating pressure for a minimum of one hour. No loss of pressure shall be permitted.</p> <p>H. All refrigerant piping shall be 100% tested with the applicable ASHRAE standard - latest version.</p> <p>I. All leaks shall be repaired by tightening, remaking joints, or replacing pipe and fittings. Caulking of joints shall not be permitted.</p> <p><b>3.07 RECORD (AS-BUILT) DRAWINGS</b></p> <p>A. At the completion of the project, provide a set of reproducible prints to the Architect which reflects all changes, deviations and revisions made to the original design documents. Locations of all underground piping and utilities shall be clearly shown and dimensioned from permanent reference points such as building column lines. Record drawings shall be produced in electronic format compatible with AUTOCAD. Furnish electronic copies of all drawings in dwg format, and two (2) bond copies of all drawing sheets. **As-Built for electronic incorporation by the Design Team, as applicable, shall be redline mark-ups of the Construction Documents.</p> <p><b>3.08 OPERATING AND MAINTENANCE MANUALS AND INSTRUCTIONS</b></p> <p>A. Complete operating and maintenance manuals shall be provided to the Owner. Four copies shall be provided. Each copy shall be bound in a separate 3-ring, loose-leaf notebook. Operating instructions shall be provided for each mechanical system, and shall each include a brief system description, a simple schematic and a sequence of operation. Operating and maintenance instructions shall be provided for each piece of equipment. A control system wiring diagram shall be included in each operating and maintenance manual.</p> <p>B. Prior to final acceptance or beneficial occupancy, provide the services of a Competent Technician for not less than one (1)**two (2) days** to instruct the Owner in the operation of the mechanical systems.</p> <p><b>3.09 TESTING AND BALANCING</b></p> <p>A. Testing and balancing of the HVAC system shall be performed **in accordance with the standards of AABC and shall be performed under the direct supervision of a Certified Test and Balance Engineer** as specified in Section 23 05 93. Note that this work is to be performed under a separate Contract directly under the General Contractor. Submit four (4) copies of the test and balance report directly to the Architect.</p> <p><b>3.10 PIPING SUPPORTS</b></p> <p>A. Pipe hangers or supports shall be provided within 18" of each horizontal fitting, equipment connection, valve, etc. and within 18" of the centerline of horizontal or vertical changes in direction summing to 90° or more. Specific attention is called to vertical turns into risers.</p> <p>B. Piping supports shall be provided, at a minimum, in accordance with the greater of the below or at code minimum. Where the below or code does not address support for specific piping, supports shall be in accordance with manufacturer's requirements.</p> <table border="1"> <thead> <tr> <th>Piping Material</th> <th>Max. Horiz. Spacing</th> <th>Max. Vert. Spacing</th> </tr> </thead> <tbody> <tr> <td>Cast-iron pipe</td> <td>5'</td> <td>15'</td> </tr> <tr> <td>Copper pipe</td> <td>12'</td> <td>10'</td> </tr> <tr> <td>Copper tubing ≤ 1-1/4" dia.</td> <td>6'</td> <td>10'</td> </tr> <tr> <td>Copper tubing ≥ 1-1/2" dia.</td> <td>10'</td> <td>10'</td> </tr> <tr> <td>PVC pipe</td> <td>4'</td> <td>10*</td> </tr> </tbody> </table> <p>*Mistery guide required for piping 2" diameter and smaller</p> <p>C. Riser clamps shall be provided at each floor penetration. For pressurized piping systems except refrigerant suction and liquid service, provide vibration isolation at all riser clamps with two (2) pad-type mountings consisting of a minimum 3/8" thick ribbed or waffled elastomeric pads bonded between minimum 16-gauge galvanized steel separator plates. Pads shall be sized for a deflection of 0.12" to 0.16". Pads shall be minimum 3" x 3" square.</p> <p><b>3.11 WARRANTY</b></p> <p>A. The exterior surfaces of all mechanical equipment, piping, ductwork, conduit, etc., shall be cleaned and free of all dirt, grease, oil, paint spatter, and other construction debris.</p>	Piping Material	Max. Horiz. Spacing	Max. Vert. Spacing	Cast-iron pipe	5'	15'	Copper pipe	12'	10'	Copper tubing ≤ 1-1/4" dia.	6'	10'	Copper tubing ≥ 1-1/2" dia.	10'	10'	PVC pipe	4'	10*
Piping Material	Max. Horiz. Spacing	Max. Vert. Spacing																					
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PVC pipe	4'	10*																					
1	2	3	4	5	6	7	8	9															

DRAWING NO.  
**CFD-XXX-M-0001-XXXXXX**




MAILING ADDRESS:  
P.O. BOX 1007  
CHARLOTTE, NC 28201

**Safety Expectations:**




Reduce Risk  
Remove Exposures to Hazards  
Reinforce Safe Behavior



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BWA JOB # 2022-0632



SEAL 05/24/23

**DUNN OPERATIONS CENTER**

1269 JONESBORO RD.  
HARNETT COUNTY, NC 28334

**OPERATIONS BUILDING**

REVISION										ISSUED - FOR CONSTRUCTION
MARK	DATE									05-24-23

PROJECT NO:  
DRAWING NUMBER  
**CFD-XXX-M-0001-XXXXXX**

ELECTRONIC FILE NAME: M0001.DWG

DRAWN BY: TAYLOR SUBER

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SHEET TITLE:  
**SPECIFICATIONS - MECHANICAL**

SHEET NO.  
**M-0001**

A. All work provided under this Division 23 shall be subject to a minimum one year warranty. The warranty shall include prompt repair or replacement of equipment or system failures and shall include all parts, refrigerant, and labor. In addition, all compressors shall carry an additional four year parts-only warranty. Extended warranties shall be provided on all other equipment so specified in other Sections.

3.14 SHOP DRAWINGS

A. Shop drawings per the submittal requirements shall be submit to the Design Team with adequate time for multiple rounds of review. Shop drawings shall show "As-Built" conditions including elevations, offsets, transitions, and accessories. Shop drawings shall indicate all code and manufacturer's recommended clearances, and coordinate the clearance and access requirements with all other trades.

B. Shop drawings that use keynotes direct from the Design Documents shall not be acceptable as they do not demonstrate coordination with all other trades, necessary transitions, etc.

C. Shop drawings shall be provided as complete packages in parallel with all trades to document coordination. Floor-by-floor or otherwise piecemeal shop drawings are generally not acceptable.

3.17 BID REQUIREMENTS

A. The Contractor shall include all systems, equipment and accessories shown on the plans and specifications.

B. The Contractor is responsible for providing all design documents to all SubContractors. All systems, equipment and accessories shall be included in the bid, whether shown on the SubContractor applicable plans or other design documents.

C. Should any discrepancy occur in the Design Documents, the Contractor shall provide a request for clarification prior to bid or note the discrepancy in the bid and provide an appropriate cost allowance in the bid.

D. The Contractor shall acknowledge that the Design Documents are diagrammatic and shall provide all systems, equipment and accessories required for a complete facility. Any areas that appear to be void of systems or inappropriate systems shall be noted in the bid. No post bid change order shall be considered for omissions or discrepancies not noted in the bid.

E. All installation coordination and means and methods and labor and materials required for proper system installation shall be included.

F. These requirements are in addition to bid procedures and requirements of the RFP or general specifications.

END OF SECTION

SECTION 23 05 93  
TESTING, ADJUSTING, AND BALANCING FOR HVAC

**1.0 GENERAL**

1.01 DESCRIPTION

A. All work specified in this Section is governed by the Common Work Results for HVAC Section 23 05 00.

B. This Section 23 05 93 and the accompanying drawings cover the provision of all labor, equipment, appliances, and materials and performing all operations in connection with the testing and balancing (T&B) of the heating, ventilating and air conditioning (HVAC) systems as specified herein and as shown. These systems include, but are not limited to, the following:

- Supply distribution systems
- Return and exhaust air systems
- Heating, ventilating and air conditioning equipment (all scheduled equipment as a minimum)
- Hydronic systems

1.02 INTENT

A. It is the intent of this Section of the specifications to provide a complete operable and balanced HVAC system as shown and specified which is reasonably airtight, comfortable and free of objectionable noise and vibration.

1.03 SCOPE OF WORK

A. HVAC test and balance shall be performed by an Independent Agency certified by the Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB) under direct contract to the General Contractor. All work performed by this Agency shall be performed by qualified Technicians under the direct supervision of an AABC or NEBB Certified Test and Balance Engineer. The Agency shall be independent and shall not be associated in any way with the installing HVAC SubContractor.

C. HVAC Test and Balance shall be performed in accordance with the 7th edition of the AABC National Standards, 2016 for Total System Balance or the NEBB Procedural Standards for TAB of Environmental Systems, 8th Edition, 2015 together with the NEBB TAB Manual for Technicians, 2<sup>nd</sup> Edition.

D. The final Test and Balance report shall serve to substantiate compliance with the intent of the Contract Documents, specifically the HVAC systems.

E. HVAC Test and Balance shall not begin until the systems are substantially complete.

F. Upon the completion of the Test and Balance work, the Agency shall submit four (4) copies of the complete HVAC Test and Balance Report directly to the Architect.

G. The Agency, as a part of its contract with the General Contractor, shall act as an Authorized Inspection Agency, responsible to the General Contractor and the Architect and shall, during the test and balance, list those items which require correction or have not been installed in accordance with the Contract Documents.

H. The Agency shall plainly mark the settings of all valves, dampers and other adjustable devices. If a balancing device is provided with a memory stop, it shall be set, locked and marked.

I. The Agency shall record all of the final set points on all variable speed drives.

1.04 SUBMITTALS

A. The name and certification of the Agency, along with the name and certification of the Certified Test and Balance Engineer, shall be submitted to the Architect for review within 30 days after the award of the General Contract.

B. The selected Agency shall submit to the Owner:

- Procedural Manual
- Report Forms
- AABC or NEBB Performance Guaranty
- Instrument List and Calibration Dates
- Schedule
- Floorplans as Needed to Uniquely Identify Device Locations

C. A reviewed copy of each of the above shall be returned to the Agency before the HVAC Test and Balance begins.

D. If a complete submittal in accordance with these requirements is not received within 60 days from award of the General Contract, then the Architect reserves the right to select the Agency.

**2.0 PRODUCTS**

2.01 (Not applicable).

**3.0 EXECUTION**

3.01 GENERAL CONTRACTOR'S DUTIES

A. The General Contractor shall provide the following, within 10 days after his receipt, to the Agency:

- Contract Drawings
- Contract applicable specification Division 23 (others as applicable)

3. Addenda

4. Change orders

5. Revised submittals

B. The General Contractor shall start-up and maintain the HVAC systems and shall continue the operation of the HVAC systems during each day of testing and balancing. Start-up and operation shall include, as a minimum, the following:

- All equipment operable and in safe condition.
- Temperature control system complete.
- Proper thermal overload protection in place for electrical equipment.
- Ductwork leakage rates not exceeding those specified and all duct systems clean of debris.
- Air transfer systems shall have:
  - Correct fan rotation and RPM.
  - Coil fins cleaned and combed.
  - Filters clean and in place.
  - Access doors closed.
  - All dampers in place and open.
  - All grilles, registers and diffusers installed.

C. Provide sufficient time before final completion date so that testing and balancing can be accomplished. Coordinate the submitted T&B schedule.

D. Provide immediate labor and tools to make required corrections and repairs without undue delay.

E. The General Contractor and his SubContractors shall cooperate fully with the Agency to provide the following:

- Access to HVAC system components.
- The right to adjust the systems.

F. Any conditions which prevent a proper HVAC Test and Balance shall be reported by the Agency to the General Contractor and Architect within 7 days of their discovery.

G. If it is determined by the Agency and confirmed by the Architect that drive changes or additional balancing dampers are required, the Contractor shall obtain and install all necessary components.

H. The Agency shall cooperate with the Architect and the Contractor and all his SubContractors to perform the work in such a manner as to meet the job schedule.

I. The Agency shall verify that all system components are in place and in proper working order prior to leaving the project.

J. All reported and recorded data shall represent true measured conditions.

K. Where equipment uses variable speed drives, and where feasible, VFDs shall be used as the primary balancing method prior to adjustment or balancing of valves, dampers, etc.

END OF SECTION

SECTION 23 07 13  
DUCT INSULATION

**1.0 GENERAL**

1.01 DESCRIPTION

A. All work specified in this Section is governed by the Common Work Results for HVAC Section 23 05 00.

B. This Section 23 07 13 and the accompanying drawings cover the provisions of all labor, equipment, appliances, and materials and performing all operations in connection with the construction of the ductwork systems as specified herein and as shown. These systems include, but are not limited to, the following:

- Insulation for typical ductwork
- Duct liner

1.02 INTENT

A. It is the intent of this Section of the specifications to provide a complete operable duct system as shown and specified which is reasonably airtight, free of noise, vibration and sweating, and fabricated so as to fit into the space allotted and to exhibit a minimum resistance to airflow.

**2.0 PRODUCTS**

2.01 DUCT LINER

A. Duct liner shall be one inch thick, 1 1/2 lb. density (3 lb. density on medium- and high-pressure supply air systems except that 1 1/2 lb. density is acceptable if the liner is at least R 4.42 and NRC 0.065) fibrous glass with one face coated with a black fire retardant compound. The permanent composite fire and smoke hazard rating of the liner shall be stenciled on the liner face and shall be:

- Maximum Flame Spread 25
- Maximum Smoke Developed 50

2.02 TYPICAL DUCT INSULATION

A. Duct insulation shall be 2" thick, minimum 3/4 lb. density fiberglass with an FSKL 0.00035" thick aluminum foil jacket, reinforced with fiberglass scrim. Thermal conductivity shall be a maximum of K = 0.29 at 75°F mean temperature, or a maximum of K=0.27 at 25% temperature.

B. Insulation adhesive shall be Benjamin Foster 85-20. Tape shall be aluminum foil and shall be SMACNA listed and labeled.

C. The composite NFPA 90A and 90B, ASTM E84, UL rating of the installed insulation shall not exceed 25/50.

D. The grease exhaust ductwork shall have zero-clearance to combustibles wrap from the hood connection to discharge termination. Coordinate the insulation with all required access panels, drains, etc. as required by NFPA 96.

2.03 INSULATION FOR DUCTWORK OUTSIDE

A. See specification 23 31 00 for duct construction installed outside the building and exposed to weather. Note requirement for soldered or welded duct. Ductwork installed outside shall be provided with a cover as noted below with water-proof coating and seams. Seams shall be located so as to not be subject to water flow. Cover shall be painted a light colour as selected by the Owner. All ductwork installed outside shall be constructed with sloped top "watershed" design with a slope of not less than 2% to avoid ponding water. Any ductwork supports connected directly to the ductwork shall also abide by the insulation requirements below.

- Ductwork conveying conditioned air shall, in addition, have minimum R-12 insulation of one of the following options:
  - 3" thick, 3 PCF density rigid fiberglass board insulation with foil-kraft facing with Venture Clad, or equal, vinyl cover.
  - 3" thick, 3 PCF density rigid fiberglass board insulation with foil-kraft facing with Polyguard, or equal, self-adhesive, self-healing membrane with 100% elongation factor.
  - 2" thick polyisocyanurate board insulation with vinyl cover or membrane per the options above.
- As an alternate to single wall duct and exterior insulation, ductwork installed outside may be double-walled meeting SMACNA requirements, R-12 insulation between walls, and the exterior wall shall be corrosion-coated for outside installation. Ductwork shall be weathertight.
- Access into ductwork installed outside shall be located inside the building where feasible. Where outside access is required, access shall be through removable cover and insulation to match the above requirements. Removable areas shall be permanently labeled on the outside and shall be insulated to minimize exposure to water infiltration.

**3.0 EXECUTION**

3.01 INSTALLATION

A. Ductwork shall be installed in strict accordance with SMACNA, UL, and NFPA standards.

B. Duct liner shall be provided throughout all return air, transfer and plenums. Duct liner shall also be provided for the following minimum distances, through the first elbow(s), or as otherwise indicated on the drawings, whichever is greater, downstream of each unit indicated below.

- Packaged rooftop unit - 25 ft
- Split system air handling unit - 5 ft
- Terminal unit - 5 ft

C. Straight runs only shall be factored into the above distance requirements. Elbows, etc., within the length shall be lined but shall not count towards the length requirement.

D. Duct liner shall not be installed within six inches of a damper, including fire and/or smoke dampers. Metal nosings are required on the downstream side of the exposed insulation. Where lining has been interrupted, external insulation is required.

E. Duct liner shall be cut to provide overlapped and compressed longitudinal corner joints. Liner shall be installed with the coated surface facing the air stream. Duct liner shall be adhered to the ductwork with a 100% coverage of the sheet metal surfaces using a fire retardant adhesive applied by spraying. Coat all exposed leading edges and all transverse joints with fire retardant adhesive. The liner shall be additionally secured using metal pins welded to the duct and speed washers. All leading edges shall be secured with sheet metal airfoils.

F. Inside the vapor barrier of the building all supply air ductwork which is not lined shall be insulated. All supply air ductwork which is on the top floor, downstream of a PIU serving an exterior exposure or is within 25 feet of an exterior door shall be insulated. All outside air ductwork shall be insulated. Insulation shall be cut slightly longer than circumference of duct to insure full thickness at corners. All insulation shall be applied with edges tightly bonded. Insulation shall be adhered to duct with fire resistant adhesive. Adhesive shall be applied so that insulation conforms to duct surfaces uniformly and firmly. In addition to the adhesive, the insulation shall be additionally secured to the bottom of all ducts 18" or wider by means of welded pins and speed clips. The protruding end of the pins shall be cut off flush after the speed clips have been applied. The vapor barrier facing shall be thoroughly sealed with tape where the pins have pierced through. All joints shall be sealed with 2" wide SMACNA tape. Any cuts or tears shall be sealed with SMACNA tape.

G. All outside air ductwork located in conditioned or semi-conditioned spaces shall be externally insulated similar to supply ductwork.

H. All conditioned air ductwork, including partially conditioned energy recovery ventilator outside air supply to the building and exhaust ductwork, installed in spaces that are ventilated only, i.e. penthouses, shall be insulated.

END OF SECTION

SECTION 23 07 19  
HVAC PIPING INSULATION

**1.0 GENERAL**

1.01 DESCRIPTION

A. All work specified in this Section is governed by the Common Work Results for HVAC Section 23 05 00.

B. This Section 23 07 19 and the accompanying drawings cover the provisions of all labor, equipment, appliances, and materials and performing all operations in connection with the installation of the HVAC piping systems as specified herein and as shown for the heating, ventilating and air conditioning (HVAC) systems. These insulated piping systems include, but are not limited to, the following:

- Refrigerant suction and liquid (RS&L)
- Condensate drains (indoors only)

C. All insulation products installed indoors shall meet NFPA 90A, 90B and 255 requirements for Flame Spread Rating 25 and Smoke Developed Rating 50.

D. Inserts for all piping which is specified to have hangers outside the insulation shall be provided at such hangers and supports for all piping 2" and larger. Inserts shall be Foamglas insulation, and shall be at least 2" longer than the length of the associated pipe shields.

1.02 INTENT

A. It is the intent of this Section of the specifications to provide a complete piping insulation system which is free of gaps and tears, properly fitted and finished, free of sweating, and fabricated so as to fit the space allotted and to exhibit a negligible heat transfer.

B. The word "piping" is defined to mean all piping, fittings, joints, hangers, coatings, valves, cocks, test and sensor wells and accessories necessary for the HVAC piping systems described, shown and specified.

1.03 ACCEPTABLE MANUFACTURERS

A. Insulation products shall be as manufactured by Owens Corning, Knafuf, Manville, Certainteed, Dow, Armacell, or Armstrong.

**2.0 PRODUCTS**

2.01 PIPING INSULATION

A. Piping insulation installed inside the building, except for the refrigerant suction and liquid service, shall be fiberglass preformed pipe insulation with a white oil-service jacket/vapor barrier. Insulation shall have a maximum K of 0.27 BTU-in/hr/ft<sup>2</sup>/F, at a mean temperature of 75°F. For pipe sizes larger than 1.5", 2" thick insulation shall be used; and for pipe sizes 1.5" and smaller, 1.5" thick insulation shall be used.

B. Piping insulation installed outside the building, except for the refrigerant suction service, shall be prefabricated 2 lb/ft<sup>3</sup> density polyisocyanurate insulation (Tymer 2000 XP or approved equal) with waterproof mastic and glass fiber jacket finished with an aluminum jacket with waterproof silicone caulk joints and seams. Outside the building, insulation with a maximum K of 0.19 BTU-in/hr/ft<sup>2</sup>/F at a mean temperature of 75°F shall be used. Outdoor piping 1.5" and smaller shall be insulated with 1.5" thick insulation; outdoor piping larger than 1.5" shall be insulated with 2" thick insulation.

C. Piping insulation installed underground, either inside or outside the building, shall be prefabricated 2 lb/ft<sup>3</sup> density polyisocyanurate insulation (Tymer 2000 XP or approved equal) with HDPE jacket. Jacket shall conform to ASTM D1248 and D3350, be extruded, have a minimum thickness of 175 mils.

D. Closed-cell insulation shall be provided over all refrigerant suction piping and other services as specified or noted. Closed-cell piping insulation shall be 1-1/2" thick 25/50 Armaflex or Rubatex. All gues and coatings shall be products of the same Manufacturer as the insulation.

E. Insulation shall be continuous over all valve bodies, fittings, and wall and floor penetrations. Do not insulate unions on hot water piping; nor instruments, gauges, valve handwheels, etc. on any piping.

F. All piping insulation covering water-carrying piping which is exposed to the weather and subject to bursting from freezing temperatures shall have oversized insulation to accommodate heating cable. See Section 23 05 33.

G. Provide a continuous watertight aluminum jacket and fitting covers for all polyisocyanurate insulation piping exposed to the weather.

**3.0 EXECUTION**

3.01 INSTALLATION OF PREFORMED PIPE INSULATION

A. Indoors

- Preformed pipe insulation with oil-service jackets shall have all longitudinal joints lapped by a minimum of 2" and sealed with fire retardant adhesive. Butt joints shall be sealed with 3" wide tape similar to the insulation vapor barrier jacket and secured with adhesive.
- All elbows shall be insulated with preformed fitted insulation equal to the thickness specified for the adjacent piping insulation. As an alternative, provide fitting covers meeting NFPA/UL 25/50 ratings; stuff all covers with fiberglass insulation having characteristics equal to adjacent pipe insulation.

B. Outdoors

- Preformed pipe insulation for exterior water-carrying pipe shall have insulation secured on with copper wire with ends twisted and turned into the insulation. Over the insulation, apply mastic to a minimum 1/4" thickness and draw in, while mastic is wet, glass fiber cloth. Finish with aluminum jacket with waterproof silicone caulk joints and seams. All seams shall be overlapped in the direction of rainfall, as practical.
- All elbows shall be insulated with preformed fitted insulation equal to the thickness specified for the adjacent piping insulation.
- All water-carrying piping subject to freezing weather shall have self-regulating electric heat tracing installed as specified in Section 23 05 33.

3.02 CLOSED-CELL PIPING INSULATION INSTALLATION

A. Insulation shall be provided on all refrigerant suction and indoor cooling coil condensate drain lines. The insulation shall be installed by the slip-on method, slitting of the insulation is prohibited and shall be cause for rejection. All elbows shall be mitered and all such joints and butt joints shall be tightly made and glued.

B. All insulation installed outdoors shall be coated with a glossy white, ultraviolet protective coating applied in two coats.

3.03 MISCELLANEOUS REQUIREMENTS

A. Where insulation is installed over pipe hangers, supports, etc., seal vapor barrier at all penetrations. Also seal all end joints at unions and points of termination by bevel cutting, the mastic and drawing jacket over until sealed to the pipe. Apply white mastic to all end seals over jacket.

END OF SECTION

SECTION 23 21 00  
HYDRONIC PIPING

**1.0 GENERAL**

1.01 DESCRIPTION

A. All work specified in this Section is governed by the Common Work Results for HVAC Section 23 05 00.

B. This Section 23 21 00 and the accompanying drawings cover the provisions of all labor, equipment, appliances, and materials and performing all operations in connection with the construction of the piping systems as specified herein and as shown for the heating, ventilating and air conditioning (HVAC) systems. These piping systems include, but are not limited to, the following:

- Refrigerant suction and liquid (RS&RL)
- Drains (DR)
- Valves and Accessories

1.02 INTENT

A. It is the intent of this Section of the specifications to provide complete and operable piping systems as shown and specified which are free of leaks, properly vented, free of noise, vibration and sweating, and fabricated so as to fit the space allotted and to exhibit a minimum resistance to fluid flow.

B. The word "piping" is defined to mean all piping, fittings, joints, hangers, coatings, valves, cocks, test and sensor wells and accessories necessary for the HVAC piping systems described, shown and specified.

1.03 GENERAL REQUIREMENTS

A. Provide all reducing fittings, flanges, couplings and unions of the size and type of material to match the piping to which equipment, valve and accessory.

B. Union joints or flanges shall be provided in each pipeline connected to each piece of equipment and elsewhere as indicated and specified. Unions shall match the piping system in which they are installed.

- Unions or flanges shall be provided between all copper to steel connections in water-carrying piping. These unions shall be dielectric, insulating type.

C. All changes in direction and branches shall be made with manufactured fittings.

D. In all water piping systems, changes in horizontal pipeline sizes shall be made with eccentric reducers installed flat on top for proper air venting. Reducing tees, reducing elbows and concentric reducers shall only be allowed for changing pipe sizes in vertical risers and for making connections to equipment and accessories from vertical risers.

E. In refrigerant, drain, steam and condensate piping systems, eccentric reducers shall be installed with the flat side on bottom to maintain the bottom of the pipe flush for proper condensate and oil drainage. Reducing tees, reducing elbows and concentric reducers shall only be allowed for changing pipe sizes in vertical risers and for making connections to equipment and accessories from vertical risers.

F. All pipe joints shall be cut square and all burrs shall be removed.

G. All butt-weld pipe elbows shall be long radius type.

H. Fabrication of a bullhead tee connection is strictly prohibited.

I. Each pump shall be provided with a straight run of piping into the suction of a length not less than five (5) times the suction pipe size indicated and/or shall be equipped with a suction diffuser. Straight runs shall be provided whenever feasible.

J. Open ends of pipelines not currently being handled shall be plugged during installation to keep dirt, water and foreign material out of the system.

K. Horizontal water supply and return piping shall be installed level or, where space permits, slope up in the direction of flow at 1/2 to 1 percent of the run.

L. Horizontal \*steam, condensate return, refrigerant and drain piping shall slope down in the direction of flow at a minimum slope of 1/8" per foot of run.

M. All Welders employed at this project shall be qualified under the requirements of ANSI Specification B31.1.0, Section 127.5. Evidence of Welders' qualifications shall be submitted before any welds are made.

**2.0 PRODUCTS**

2.01 PIPE AND FITTINGS

A. All pipe and fittings shall be products of a domestic Manufacturer.

B. Pipe and fittings shall be as listed and outlined below:

- Refrigerant Suction and Liquid, All Sizes: Material 4
- All other drains, All Sizes: Material 6

C. The pipe, fittings and joints shall be as outlined below:

- Material Type 4:
  - Pipe - Type L hard drawn copper tubing meeting ASTM B88 or ASTM B280.
  - Fittings - Wrought copper meeting ANSI B16.22.
  - Joints - Silver brazed with sil-fos or silver solder.
- Material Type 6:
  - Pipe - Copper drainage tube DWV meeting ASTM B306.
  - Fittings - Wrought copper solder-joint drainage fittings meeting ANSI B16.29.
  - Joints - Soldered with a solder meeting ASTM B32.

2.02 VALVES

A. All valves shall have the Manufacturer's name or trademark and the working pressure cast or stamped on the valve body.

B. All valves utilizing packing shall be designed and constructed to allow repacking while under pressure.

C. All valves shall be provided by a domestic Manufacturer.

D. All valves 3/4" and smaller shall be "full-port" type, and greater than 3/4" may be "reduced-port" type.

E. Valves on insulated lines shall be provided with stem extensions to provide clearance for specified pipe insulation. Provide preformed insulation to encase valve assembly in insulated piping systems.

F. Valves shall be suitable for 125 psig and 40F to 250F or the system operating conditions, whichever is greater, UON.

J. Check valves:

- Check valves 2-1/2" and larger shall be non-slam type with iron body, globe-type silent checks with bronze trim, stainless steel spring and flanged and connections. Flow area through the valve shall exceed the cross sectional area of the pipe in which the valve is installed by not less than 10%. Valves shall be Apollo Valves 910F up to 200 psi or 2" and under, 169T up to 600 psi or equal by Mueller Co., APCO, Metroflex Globe Style Silent Check Valve, Hammond IR 9354, or Milwaukee 1800 in grooved piping systems, valves shall be Victaulic 716, 779, or W715 as appropriate.
- Check valves 2" and smaller shall be y-pattern, swing-type with brass body, renewable bronze seat disc, and be MSS SP-80 factory-tested. Valves shall be Apollo Valves 164T for up to 200 psi CWP and 168T for up to 400 psi CWP or equal by Hammond, or Milwaukee.
- All check valves on pump discharges shall be non-slam type.
- All check valves shall be installed in an orientation allowed by the manufacturer's recommendations.
- All check valves installed in insulated piping systems shall have the check valve location explicitly labeled on the outside of the insulation.

L. Control valves shall meet the requirements of the appropriate valve sections. Control valves shall be provided with electric operator/actuators which shall provide full modulation from closed to open and positive closure. Operators/actuators and all components shall be plenum-rated in return air plenums.

M. Relief valves shall be sized to have the pressure and temperature relief capacities indicated by their service, including any piped discharge sizes and lengths. Relief valves shall be ASME rated and labeled.

2.03 FLEXIBLE PIPE CONNECTIONS

N. Flexible piping connections for individual small HVAC units such as fan coil units, water-source heat pumps, and water coils shall be provided with each unit or coil. Flexible supply and return hoses shall be a minimum of 24" complete with service shut-off valves. Hose assembly shall be stainless steel outer braid and EPDM inner tube. Hoses shall have insulation to match insulation specification requirements. Hoses shall be rated for the system pressure and temperature in which they are installed and not less than 40F to 250F, 300 psig.

O. Flexible piping connections are for vibration isolation only and shall not be used to align piping connections, for thermal expansion, or any other purpose.

2.08 THERMOMETERS AND PRESSURE GAUGES

A. Thermometers and pressure gauges shall be products of Terrice, Wekster or Weiss. Select all devices to operate within 20% of the midpoint of their scales under normal operating conditions. Gauges provided on pumps shall be compound type.

2.09 PRESSURE AND TEMPERATURE (P&T) TEST PLUGS

A. Plugs shall be constructed of brass with two (2) self-closing Nardel cores and be complete with cap and gasket.

B. Plugs shall be as manufactured by Peterson or Lancaster.

C. Provide a complete test kit to the Owner at the time of final inspection. Test kit shall be complete with pressure gauge, thermometer, probes and carrying case.

**3.0 EXECUTION**

3.01 ARRANGEMENT

A. Follow the general piping layout, arrangement, schematics, and details. Provide all offsets, air vents, drains and connections necessary to accomplish the installation. Automatic air vents shall be provided at all high points. Manual air vents shall be installed as required for system fill, troubleshooting, and testing. Fabricate piping accurately to measurements established at the project Site to avoid interference with ductwork, other piping, equipment, openings, electrical conduits and light fixtures.

B. Make suitable provision for expansion and contraction with expansion loops and offsets. With Engineer approval, Victaulic Style 177, 77, or W77, as appropriate, flexible couplings or Style 155 expansion joint may be used to accommodate expansion and contraction. \*Victaulic shall be consulted to ensure proper application and design. Victaulic shall provide details and calculations where required.

C. Pressure gauges and thermometers called to be permanently installed shall be easily visible from a standing position on the ground.

3.02 UNDERGROUND PIPING

A. All underground piping shall have a minimum cover of 3'-0".

B. Provide concrete thrust blocks at all changes of direction and secure all joints.

C. All underground water lines shall be protected from corrosion with a continuous plastic sheathing or coating and wrapping. This sheathing or coating and wrapping shall be extended 6" to 12" above finished floor. See Section 23 07 19 for HVAC piping insulation.

3.03 REFRIGERANT PIPING INSTALLATION

A. All refrigerant piping shall be sized in accordance with the Air Conditioning Equipment Manufacturer's written instructions. Provide charging ports, solenoid valves, service valves, dryers, etc. at each piece of equipment.

B. All brazing shall be done while the line is being flushed with carbon dioxide, nitrogen, or other inert gases.

C. The inside of all tubing shall be thoroughly cleaned and internally wiped with a lintless, dry cloth.

D. Suction lines shall drop below their coils before any horizontal run.

E. Provide oil traps at least every ten feet for extended vertical risers.

F. All oil traps shall be constructed from close-radius type fittings.

G. Dryer cores shall be installed to remove horizontally or downward.

H. Install external equalizer downstream of its expansion valve sensing bulb.

I. Install expansion sensing valve bulb on top centerline of piping up to 5/8" size; install 45 degree down from the horizontal centerline on pipe sizes 7/8" and larger.

END OF SECTION

SECTION 23 31 00  
HVAC DUCTS, ACCESSORIES, AND CASINGS

**1.0 GENERAL**

1.01 DESCRIPTION

A. All work specified in this Section is governed by the Common Work Results for HVAC Section 23 05 00.

B. This Section 23 31 00 and the accompanying drawings cover the provisions of all labor, equipment, appliances, and materials and performing all operations in connection with the construction of the ductwork systems as specified herein and as shown. These systems include, but are not limited to, the following:

- Supply air ductwork
- Return, transfer and relief air ductwork
- Exhaust ductwork

C. All valves shall be provided by a domestic Manufacturer.

D. All valves 3/4" and smaller shall be "full-port" type, and greater than 3/4" may be "reduced-port" type.

E. Valves on insulated lines shall be provided with stem extensions to provide clearance for specified pipe insulation. Provide preformed insulation to encase valve assembly in insulated piping systems.

F. Valves shall be suitable for 125 psig and 40F to 250F or the system operating conditions, whichever is greater, UON.

J. Check valves:

- Check valves 2-1/2" and larger shall be non-slam type with iron body, globe-type silent checks with bronze trim, stainless steel spring and flanged and connections. Flow area through the valve shall exceed the cross sectional area of the pipe in which the valve is installed by not less than 10%. Valves shall be Apollo Valves 910F up to 200 psi or 2" and under, 169T up to 600 psi or equal by Mueller Co., APCO, Metroflex Globe Style Silent Check Valve, Hammond IR 9354, or Milwaukee 1800 in grooved piping systems, valves shall be Victaulic 716, 779, or W715 as appropriate.
- Check valves 2" and smaller shall be y-pattern, swing-type with brass body, renewable bronze seat disc, and be MSS SP-80 factory-tested. Valves shall be Apollo Valves 164T for up to 200 psi CWP and 168T for up to 400 psi CWP or equal by Hammond, or Milwaukee.
- All check valves on pump discharges shall be non-slam type.
- All check valves shall be installed in an orientation allowed by the manufacturer's recommendations.
- All check valves installed in insulated piping systems shall have the check valve location explicitly labeled on the outside of the insulation.

L. Control valves shall meet the requirements of the appropriate valve sections. Control valves shall be provided with electric operator/actuators which shall provide full modulation from closed to open and positive closure. Operators/actuators and all components shall be plenum-rated in return air plenums.

M. Relief valves shall be sized to have the pressure and temperature relief capacities indicated by their service, including any piped discharge sizes and lengths. Relief valves shall be ASME rated and labeled.

2.03 FLEXIBLE PIPE CONNECTIONS

N. Flexible piping connections for individual small HVAC units such as fan coil units, water-source heat pumps, and water coils shall be provided with each unit or coil. Flexible supply and return hoses shall be a minimum of 24" complete with service shut-off valves. Hose assembly shall be stainless steel outer braid and EPDM inner tube. Hoses shall have insulation to match insulation specification requirements. Hoses shall be rated for the system pressure and temperature in which they are installed and not less than 40F to 250F, 300 psig.

O. Flexible piping connections are for vibration isolation only and shall not be used to align piping connections, for thermal expansion, or any other purpose.

2.08 THERMOMETERS AND PRESSURE GAUGES

A. Thermometers and pressure gauges shall be products of Terrice, Wekster or Weiss. Select all devices to operate within 20% of the midpoint of their scales under normal operating conditions. Gauges provided on pumps shall be compound type.

2.09 PRESSURE AND TEMPERATURE (P&T) TEST PLUGS

A. Plugs shall be constructed of brass with two (2) self-closing Nardel cores and be complete with cap and gasket.

B. Plugs shall be as manufactured by Peterson or Lancaster.

C. Provide a complete test kit to the Owner at the time of final inspection. Test kit shall be complete with pressure gauge, thermometer, probes and carrying case.

**3.0 EXECUTION**

3.01 ARRANGEMENT

A. Follow the general piping layout, arrangement, schematics, and details. Provide all offsets, air vents, drains and connections necessary to accomplish the installation. Automatic air vents shall be provided at all high points. Manual air vents shall be installed as required for system fill, troubleshooting, and testing. Fabricate piping accurately to measurements established at the project Site to avoid interference with ductwork, other piping, equipment, openings, electrical conduits and light fixtures.

B. Make suitable provision for expansion and contraction with expansion loops and offsets. With Engineer approval, Victaulic Style 177, 77, or W77, as appropriate, flexible couplings or Style 155 expansion joint may be used to accommodate expansion and contraction. \*Victaulic shall be consulted to ensure proper application and design. Victaulic shall provide details and calculations where required.

C. Pressure gauges and thermometers called to be permanently installed shall be easily visible from a standing position on the ground.

3.02 UNDERGROUND PIPING

A. All underground piping shall have a minimum cover of 3'-0".

B. Provide concrete thrust blocks at all changes of direction and secure all joints.

C. All underground water lines shall be protected from corrosion with a continuous plastic sheathing or coating and wrapping. This sheathing or coating and wrapping shall be extended 6" to 12" above finished floor. See Section 23 07 19 for HVAC piping insulation.

3.03 REFRIGERANT PIPING INSTALLATION

A. All refrigerant piping shall be sized in accordance with the Air Conditioning Equipment Manufacturer's written instructions. Provide charging ports, solenoid valves, service valves, dryers, etc. at each piece of equipment.

B. All brazing shall be done while the line is being flushed with carbon dioxide, nitrogen, or other inert gases.

C. The inside of all tubing shall be thoroughly cleaned and internally wiped with a lintless, dry cloth.

D. Suction lines shall drop below their coils before any horizontal run.

E. Provide oil traps at least every ten feet for extended vertical risers.

F. All oil traps shall be constructed from close-radius type fittings.

G. Dryer cores shall be installed to remove horizontally or downward.

H. Install external equalizer downstream of its expansion valve sensing bulb.

I. Install expansion sensing valve bulb on top centerline of piping up to 5/8" size; install 45 degree down from the horizontal centerline on pipe sizes 7/8" and larger.

END OF SECTION

SECTION 23 31 00  
HVAC DUCTS, ACCESSORIES, AND CASINGS

**1.0 GENERAL**

1.01 DESCRIPTION

A. All work specified in this Section is governed by the Common Work Results for HVAC Section 23 05 00.

B. This Section 23 31 00 and the accompanying drawings cover the provisions of all labor, equipment, appliances, and materials and performing all operations in connection with the construction of the ductwork systems as specified herein and as shown. These systems include, but are not limited to, the following:

- Supply air ductwork
- Return, transfer and relief air ductwork
- Exhaust ductwork

3. Addenda

4. Change orders

5. Revised submittals

B. The General Contractor shall start-up and maintain the HVAC systems and shall continue the operation of the HVAC systems during each day of testing and balancing. Start-up and operation shall include, as a minimum, the following:

- All equipment operable and in safe condition.
- Temperature control system complete.
- Proper thermal overload protection in place for electrical equipment.
- Ductwork leakage rates not exceeding those specified and all duct systems clean of debris.
- Air transfer systems shall have:
  - Correct fan rotation and RPM.
  - Coil fins cleaned and combed.
  - Filters clean and in place.
  - Access doors closed.
  - All dampers in place and open.
  - All grilles, registers and diffusers installed.

C. Provide sufficient time before final completion date so that testing and balancing can be accomplished. Coordinate the submitted T&B schedule.

D. Provide immediate labor and tools to make required corrections and repairs without undue delay.

E. The General Contractor and his SubContractors shall cooperate fully with the Agency to provide the following:

- Access to HVAC system components.
- The right to adjust the systems.

F. Any conditions which prevent a proper HVAC Test and Balance shall be reported by the Agency to the General Contractor and Architect within 7 days of their discovery.

G. If it is determined by the Agency and confirmed by the Architect that drive changes or additional balancing dampers are required, the Contractor shall obtain and install all necessary components.

H. The Agency shall cooperate with the Architect and the Contractor and all his SubContractors to perform the work in such a manner as to meet the job schedule.

I. The Agency shall verify that all system components are in place and in proper working order prior to leaving the project.

J. All reported and recorded data shall represent true measured conditions.

K. Where equipment uses variable speed drives, and where feasible, VFDs shall be used as the primary balancing method prior to adjustment or balancing of valves, dampers, etc.

END OF SECTION

SECTION 23 07 13  
DUCT INSULATION

**1.0 GENERAL**

1.01 DESCRIPTION

A. All work specified in this Section is governed by the Common Work Results for HVAC Section 23 05 00.

B. This Section 23 07 13 and the accompanying drawings cover the provisions of all labor, equipment, appliances, and materials and performing all operations in connection with the construction of the ductwork systems as specified herein and as shown. These systems include, but are not limited to, the following:

- Insulation for typical ductwork
- Duct liner

1.02 INTENT

A. It is the intent of this Section of the specifications to provide a complete operable duct system as shown and specified which is reasonably airtight, free of noise, vibration and sweating, and fabricated so as to fit into the space allotted and to exhibit a minimum resistance to airflow.

**2.0 PRODUCTS**

2.01 DUCT LINER

A. Duct liner shall be one inch thick, 1 1/2 lb. density (3 lb. density on medium- and high-pressure supply air systems except that 1 1/2 lb. density is acceptable if the liner is at least R 4.42 and NRC 0.065) fibrous glass with one face coated with a black fire retardant compound. The permanent composite fire and smoke hazard rating of the liner shall be stenciled on the liner face and shall be:

- Maximum Flame Spread 25
- Maximum Smoke Developed 50

2.02 TYPICAL DUCT INSULATION

A. Duct insulation shall be 2" thick, minimum 3/4 lb. density fiberglass with an FSKL 0.00035" thick aluminum foil jacket, reinforced with fiberglass scrim. Thermal conductivity shall be a maximum of K = 0.29 at 75°F mean temperature, or a maximum of K=0.27 at 25% temperature.

B. Insulation adhesive shall be Benjamin Foster 85-20. Tape shall be aluminum foil and shall be SMACNA listed and labeled.

C. The composite NFPA 90A and 90B, ASTM E84, UL rating of the installed insulation shall not exceed 25/50.

D. The grease exhaust ductwork shall have zero-clearance to combustibles wrap from the hood connection to discharge termination. Coordinate the insulation with all required access panels, drains, etc. as required by NFPA 96.

2.03 INSULATION FOR DUCTWORK OUTSIDE

A. See specification 23 31 00 for duct construction installed outside the building and exposed to weather. Note requirement for soldered or welded duct. Ductwork installed outside shall be provided with a cover as noted below with water-proof coating and seams. Seams shall be located so as to not be subject to water flow. Cover shall be painted a light colour as selected by the Owner. All ductwork installed outside shall be constructed with sloped top "watershed" design with a slope of not less than 2% to avoid ponding water. Any ductwork supports connected directly to the ductwork shall also abide by the insulation requirements below.

- Ductwork conveying conditioned air shall, in addition, have minimum R-12 insulation of one of the following options:
  - 3" thick, 3 PCF density rigid fiberglass board insulation with foil-kraft facing with Venture Clad, or equal, vinyl cover.
  - 3" thick, 3 PCF density rigid fiberglass board insulation with foil-kraft facing with Polyguard, or equal, self-adhesive, self-healing membrane with 100% elongation factor.
  - 2" thick polyisocyanurate board insulation with vinyl cover or membrane per the options above.
- As an alternate to single wall duct and exterior insulation, ductwork installed outside may be double-walled meeting SMACNA requirements, R-12 insulation between walls, and the exterior wall shall be corrosion-coated for outside installation. Ductwork shall be weathertight.
- Access into ductwork installed outside shall be located inside the building where feasible. Where outside access is required, access shall be through removable cover and insulation to match the above requirements. Removable areas shall be permanently labeled on the outside and shall be insulated to minimize exposure to water infiltration.

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2.01 CURB

A. Each unit shall be provided with a full perimeter roof curb. The roof curb shall be of the same Manufacturer as the unit, shall support the unit and provide a watertight enclosure to protect ductwork and utility services. Curb design shall comply with National Roofing Contractors Association requirements. Supply/return air opening gasketing shall be provided. Channel shall be provided allowing for adjustment of return air opening location to match the building structural frame indicated.

B. All duct and utility connections shall be routed through bottom of unit within the curb perimeter.

2.02 UNIT CABINETS

A. Rooftop unit cabinets shall be formed, galvanized steel construction with welded base assembly. Galvanized steel surfaces shall be bonded and painted with baked acrylic enamel for complete weather protection. All sheet metal screws shall be stainless steel. The outside air dampers shall be low leak gasketed dampers which must match unit interlock with the single package rooftop units. Cabinets shall be fully insulated.

B. Unit cabinets shall be designed for curb mounting and mate with the full perimeter roof curb for a complete weather-tight seal. Unit sides shall overhang the curb to form protective drip lip.

C. Access doors for the filter section and the fan section of all units sized 20 nominal tons and larger shall be hinged, walk-in type.

2.03 COMPRESSOR SECTION

A. Compressor section refrigeration system shall be factory charged, ready for operation, providing minimum two stage cooling capacity (50% and 100%) on units of over 5 tons capacity, minimum of three stages on units of nominal 20 and 25 tons and minimum of four stages on units larger than 25 nominal tons. Compressor protection shall include high and low pressure control, outdoor ambient protection, compressor sum heat, three-phase overload protection, anticycling timer providing a minimum five (5) minute time shut down of unit on interruption of power or automatic control shutdown. Compressors shall have factory-installed service valves, vibration isolators, crankcase heaters, liquid line sight glasses, filter driers, and liquid line service valves.

2.04 EVAPORATOR COILS

A. Coils shall be aluminum plate fins mechanically bonded to copper tubes. They shall be of an interlaminar design for equal circuit loading and to ensure a fully active coil on part-load operation to provide evenly conditioned air. Aluminum tubes shall not be acceptable.

2.05 FANS

A. Fans shall be either single or double wheels, forward-curved, Class 1 type, and mounted on a common shaft with adjustable sheave drive. All fans shall be statically and dynamically balanced and tested in the factory. Fan shall not pass through its first critical speed in order to meet the scheduled performance. Fan shaft shall be mounted on not less than two grease-lubricated ball bearings with all fan wheels mounted inboard of the bearings. The fan and motor assembly shall be mounted on a common base; on units with motor sizes larger than five (5) HP, the entire assembly shall be isolated from the rest of the unit by double deflection vibration isolators.

B. Variable air volume (VAV) units shall be complete with variable frequency inverter drives and matched inverter-duty motors.

C. Motors on VFDs shall have shaft-grounding rings.

2.06 ELECTRIC HEATING SECTIONS

A. Electric heating sections shall be furnished with nickel-chromium open coil resistance heating elements with each element protected by an automatic reset high-limit thermostat and manual reset high-limit thermostat for the primary and secondary overcurrent/thermal protection. Controls shall provide for multiple stage start-up and operation.

2.07 GAS HEATING SECTION

A. Gas heating sections shall be mounted downstream of evaporator coils and shall be certified by AGA for use on natural gas. Heating shall be accomplished with a minimum of two stages on units 7.5 tons nominal and larger.

B. Heat exchanger shall be fabricated from aluminum steel, stress-relieved and free-floating.

C. The unit shall utilize an electronic, spark-ignition pilot light; not a standing pilot.

D. Each heating system shall include an induced draft combustion air exhaust fan protected by centrifugal switches, heat limit switches, time-delay relay, flame roll-out switches and pilot sensors. Heating controls shall consist of a redundant gas valve, intermittent pilot ignition with electric spark ignition system. Each unit shall be AGA certified.

2.09 CONTROLS AND ACCESSORIES - ALL SYSTEMS

A. All operating and safety controls shall be factory-installed and shall include solid state compressor overload protection, magnetic contactors, thermostatic expansion valve, refrigerant line drier and automatic damper motors.

B. Controls on electric heat section shall meet NEMA specifications and requirements.

C. During night setback operation, morning warm-ups after night setbacks and whenever the unit is off, the outside air dampers shall be fully closed and admit no outside air.

D. Interlocks shall be made to the duct-mounted smoke detectors in each unit's supply and return ductwork to shut the unit off and fully close the return air dampers to prevent migration of smoke upon its detection.

E. Provide a factory mounted disconnect and integral powered duplex GFI convenience outlet on all units. Coordinate with Division 26.

F. Provide downflow units with accessory condensate overflow switch in the primary drain pan. Switch shall be interlocked to shut the unit off in an overflow situation.

2.10 CONTROLS - non-VVT systems

A. A 24 volt transformer shall be provided to accommodate controls and accessories. Each unit shall be complete with an indoor thermostat and control panel complete with the following minimum list of features and capabilities:

- 1. Seven day programmable electronic thermostat for programming heating and cooling temperatures as well as night setback times and temperatures.
2. Battery back-up to protect the programs for up to 24 hours after a power failure.
3. Manual overrides and a failsafe program.

2.12 FILTERS

A. Units shall have high-efficiency, 2-inch thick, low velocity throwaway filters in commercially available sizes. Filters shall be not less than 30%/30% average dust spot efficient when tested in accordance with ASHRAE Test Standard 52.2-2007; Fpr 30/30 or an approved equal.

2.13 AIRSIDE ECONOMIZER

A. An airside economizer shall be provided with each unit equal to or greater than 65 MBH nominal. The economizer shall be factory-assembled complete with dampers, electrical actuators, exhaust fans and all controls.

B. The outside air dampers shall be low-leakage type, with a maximum leakage of 3% at 3" WC static pressure. The dampers shall be spring operated to close during power failure.

C. The airside economizer shall provide "free" cooling whenever the outside air enthalpy is less than the set point of the outside air enthalpy sensor and cooling is required. The enthalpy sensor shall be adjustable for temperature and humidity setpoints.

D. If the cooling load is discharged by the airside economizer alone, no mechanical refrigeration shall be initiated and the economizer dampers shall be modulated to maintain the desired discharge air temperature. The economizer shall modulate up to its full open position to meet the cooling load. When the economizer is at its maximum outside air position and further cooling is required, mechanical refrigeration shall be utilized. When the enthalpy of the outside air is above its setpoint and during normal heating cycles, the outside air damper shall be at its minimum outdoor air position.

E. The position of the return and outside air dampers shall also be controlled as specified elsewhere in response to unit and external controls.

3.0 EXECUTION

3.01 INSTALLATION
A. The packaged rooftop units and associated controls shall be installed in strict accordance with the manufacturer's recommendations.

B. The control system shall be completely wired under this Division 23. Wiring shall be in accordance with the NEC and shall meet all requirements for this installation.

3.02 STARTUP

A. Provide the services of a factory-trained and qualified Service Technician employed by the Unit Manufacturer who shall inspect the installation including external control interlock and electrical power connections; supervise leak testing, initial operation, calibration of operating and safety controls and supervise electrical testing including insulation resistance of motors and voltage balance between phases during starting and running.

B. This Service Technician shall forward a report in four (4) copies to the Owner when the unit is in safe and proper operating condition. This report shall include all pressure and control settings, meg readings, voltage readings per phase during start and run, and shall list minor discrepancies to be corrected that affect safe and reliable operation. One additional copy of the report shall be left in the unit control panel. One copy of bound installation, operation, maintenance service and parts brochures, including applicable serial numbers, full unit description and parts ordering sources, shall be placed in the unit control panel at the time of startup; four (4) additional copies shall be forwarded to the Owner.

END OF SECTION

SECTION 23 81 26 SPLIT-SYSTEM AIR-CONDITIONERS

1.0 GENERAL

1.01 DESCRIPTION
A. All work specified in this Section is governed by the Common Work Results for HVAC Section 23 05 00.

B. This Section 23 81 26 and the accompanying drawings cover the provision of all labor, equipment, appliances and materials, and performing all operations in connection with the construction and installation of the split systems as specified herein and as shown. This work includes, but is not limited to, the following:
1. Split system fan coil, heating section and condensing units
2. Control system (interlocked to all split system components)
C. Split system units shall be self-contained, automatic, packaged units. These units shall be completely factory-assembled as unitary packages complete with operating controls, internal wiring and piping and fully charged with R-410A refrigerant. Only one electrical power connection shall be required for each unit.

D. Units shall be UL listed and cooling capacities shall be certified in accordance with ANSI/AHRI 210/240.

1.02 INTENT

A. It is the intent of this Section of the specifications to provide complete, operable, adjusted split systems, as shown and specified, which operate efficiently and automatically, and are free of excessive noise and vibration.

1.03 BASIS OF DESIGN

A. The basis of design is as scheduled. Acceptable alternate manufacturers include Trane, Carrier, Mitsubishi, Lennox, and Daikin for ducted systems except that Liebert systems are also acceptable for Server/IT spaces, and Carrier, Mitsubishi, LG, Hitachi, and Daikin for ductless mini-splits. Any proposed substitutions shall be submitted in accordance with the prior approval requirements.

2.0 PRODUCTS

2.01 UNIT CASINGS

A. Unit casings shall be formed, galvanized steel construction with welded assembly. Galvanized steel surfaces shall be bonded and painted with baked acrylic enamel for complete weather protection. Accessories and components shall match and interlock with all other split system components. Fan coil unit casings shall be fully internally insulated with liner which meets NFPA 25/50 flame spread/smoke developed ratings.

2.02 CONDENSING UNITS

A. Condensing unit refrigeration systems shall be factory-charged and ready for operation. All units with capacities greater than five (5) tons shall be provided with minimum 2-stage (50% and 100%) cooling. Compressor(s) shall be direct drive, 3600 RPM, hermetic reciprocating type with centrifugal oil pump, crankcase heater and internal pressure relief valve. Compressor(s) shall have internal spring isolation and sound muffling and exhibit minimum vibration transmission and noise. Anti-recycle timers shall be provided to prevent excessive cycling of compressors thru utilization of a minimum five (5) minute time shutdown of unit on interruption of power or controlled shutdown.

B. Condensing unit condenser fans shall be direct-driven, propeller blade type. Condensing unit heat rejection shall be vertically upward.

2.03 COILS

A. Evaporator and condenser coils shall be copper tubing mechanically bonded to heavy duty aluminum fins. Aluminum tubes shall not be acceptable.

2.07 CONTROLS AND ACCESSORIES

A. All operating and safety controls which are internal to each unit shall be factory-installed and shall include, as a minimum, solid state compressor overload protection, magnetic contactors, thermostatic expansion valve(s), refrigerant line drier(s), outdoor fan and compressor cycling thermostats, high and low limit protection against excessive temperatures or pressures.

B. A 24 volt transformer shall be provided to accommodate an accessory 24 volt indoor thermostat complete with an electronic programmable night setback, separate automatic heat/cool settings, auto/manual fan control and seasonal selector. Thermostat shall provide staging of the cooling and heating to match the stages of each component.

C. Automatic shutdown controls shall be provided on units <=2,000 CFM to meet Local Codes (or NFPA 90A as a minimum) and shall consist of fire/smoke detectors and duct-mounted smoke detectors interlocked to the fan coil unit for shutdown on the detection of fire or smoke.

3.0 EXECUTION

3.01 INSTALLATION
A. The split systems and associated controls shall be installed in strict accordance with the manufacturer's recommendations.

B. The control system shall be completely wired under this Division 23. Wiring shall be in accordance with the NEC and shall meet all requirements for this installation.

3.02 STARTUP

A. Provide the services of a factory-trained and qualified Service Technician employed by the Unit Manufacturer who shall inspect the installation including external interlock and power connections; supervise leak testing, initial operation, calibration of operating and safety controls and supervise electrical testing including insulation resistance of motors and voltage balance between phases during starting and running.

B. This Service Technician shall forward a report in four (4) copies to the Owner when the unit is in safe and proper operating condition. This report shall include all pressure and control settings, meg readings, voltage readings per phase during start and run, and shall list minor discrepancies to be corrected that affect safe and reliable operation. One additional copy of the report shall be left in the unit control panel. One copy of bound installation, operation, maintenance service and parts brochures, including applicable serial numbers, full unit description and parts ordering sources, shall be placed in the unit control panel at the time of startup; four (4) additional copies shall be forwarded to the Owner.

END OF SECTION

SECTION 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 GENERAL

1.1 DESCRIPTION
A. All work specified in this Section is governed by the Common Work Results for HVAC Section 23 05 00.

B. This Section 23 09 00 and the accompanying drawings cover the provision of all labor, equipment, appliances, and materials, and performing all operations in connection with the construction and installation of the Building Automation System (BAS) as specified herein and as shown. This work includes, but is not limited to the following:
1. Web enabled access platform
2. Remote network access capability
3. System software and graphics (on Owner central server)
4. Control panels (main and remote)
5. Space thermostats
6. HVAC system sensors
7. Control valves and dampers with actuators
8. Life safety shutdowns and interlock wiring
9. Relays, contactors, and transformers
10. Wiring (24 and 120 volt)
11. Point capacity for future interior fit-up
12. Point capacity for lighting control including future exterior and tenant fit-up
13. Point capacity for future Owner use
14. Computer for Owner control and access

C. This Service Technician shall forward a report in four (4) copies to the Owner when the unit is in safe and proper operating condition. This report shall include all pressure and control settings, meg readings, voltage readings per phase during start and run, and shall list minor discrepancies to be corrected that affect safe and reliable operation. One additional copy of the report shall be left in the unit control panel. One copy of bound installation, operation, maintenance service and parts brochures, including applicable serial numbers, full unit description and parts ordering sources, shall be placed in the unit control panel at the time of startup; four (4) additional copies shall be forwarded to the Owner.

1.2 SCOPE OF WORK

A. The scope of work includes, but is not limited to, provision of all equipment, hardware, software, programming, and graphics for a complete system of automatic temperature and pressure control, energy management and integrated life safety functions. The BAS shall be performed by a central operating system (program software) installed on a central server provided under this scope and by separate control and remote panels, controllers, relays, etc.
B. The control system shall be a 100% electronic DDC system.

C. The BAS shall include control panels and interlocks for the following as a minimum. Additional points shall be provided as required to implement the sequence of control and code required control functions. Any necessary sensors, probes, etc. shall be installed to implement the sequence of control and noted points:
1. All VAV Rooftop Units
a. Start/Stop Control with positive status indication
b. Supply Air Temperature
c. Return Air Temperature
d. Mixed Air Temperature
e. Dirty Filter Alarm
f. All Control Dampers
g. All Wiring for above
h. Interlock w/Fire Alarm System
i. Supply air static pressure
j. Adjustable point for supply air static pressure set point
k. Adjustable point for supply temperature control
l. Adjustable point for outside air flowrate
m. Compressor statuses
n. Heating status
o. Outdoor air humidity
p. Return air humidity
r. Adjustable point for differential enthalpy airside economizer
s. Supply and exhaust fan VFDs, status, speed, and motor current
l. Building pressurization setpoint
u. Current measured building pressure
2. VAV and PIU Systems:
a. Sensors and all associated wiring
b. Thermostat set point and space temperature
c. Tenant override control
d. Night setback, Morning warm up/cool down control
e. Discharge air temperature
f. Primary airflow CFM
g. Fan status
3. All Split Systems
a. Start/Stop control with positive status indication
b. Space Temperature
c. Dirty Filter Alarm
d. All Wiring for above
e. Interlock w/Fire Alarm System
f. Compressor status
g. Mini-Split System Air Conditioning Units
a. Space temperature
b. Toilet and Tenant Exhaust Fans
a. Start/Stop control with positive status indication
b. Space Temperature
c. Dirty Filter Alarm
d. All Wiring for above
e. Interlock w/Fire Alarm System
f. Compressor status
g. Mini-Split System Air Conditioning Units
a. Space temperature
b. Toilet and Tenant Exhaust Fans

4. Sensors and all associated wiring
b. Thermostat set point and space temperature
c. Tenant override control
d. Night setback, Morning warm up/cool down control
e. Discharge air temperature
f. Primary airflow CFM
g. Fan status
3. All Split Systems
a. Start/Stop control with positive status indication
b. Space Temperature
c. Dirty Filter Alarm
d. All Wiring for above
e. Interlock w/Fire Alarm System
f. Compressor status
g. Mini-Split System Air Conditioning Units
a. Space temperature
b. Toilet and Tenant Exhaust Fans

5. Life Safety Controls
a. Interlocks to the life safety controls
b. Interlocks to the fire alarm system provided under Division 28
C. Lighting Control
a. Interface to all lighting control panels or breakers
D. Miscellaneous Points
a. Capacity for future tenant fit up terminal units equipment. Include capacity for a total of twenty-five (25) tenant terminal units on each floor
b. Include capacity break out on terminals

1.3 BAS MEMORY

A. BAS CPU and controllers are not required to be provided with emergency power unless required for life safety. All CPUs, controllers, etc. are required to be provided with internal memory as described below.
B. System re-boot after power outage shall be adjusted to allow proper restart of operation of all systems.

1.4 AUTOMATIC SHUTDOWNS

A. All recirculating air systems (rooftop units, PIUs, etc.) which supply air to paths of egress (exits, corridors, lobbies, etc.) shall be provided with smoke detectors in the supply and all return air paths for automatic shutdown of that system in the event of smoke detection.
B. All recirculating air systems (rooftop units, PIUs, etc.) having a design airflow capacity of 2,000 CFM or greater shall have smoke detectors installed to detect the presence of smoke and automatically stop the fan(s).
1. In the supply system downstream of the filters
2. In the return system at each point of entry into the common return prior to any mixing with outside air

C. Smoke detectors shall be furnished by Division 26 for installation under this Division 23 in accordance with NFPA 72E. All smoke detectors shall be connected to the Life Safety System in accordance with the requirements of the NFPA Signaling System Standards (NFPA 72) such that actuation of any smoke detector will sound the Fire Alarm. No system shall reset until the Fire Alarm controls are reset. Coordinate interlocks (quantity, location, etc.) with Division 28.
D. Activation of any smoke detector shall sound an audible alarm in a normally occupied area of the building.
E. Detector trouble condition shall be indicated visually or audibly in a normally occupied area of the building and shall be identified as off detector detector failure.
F. Smoke dampers shall be installed in systems over 15,000 CFM capacity serving multiple floors to isolate the air handling equipment (including filters) from the remainder of the system so as to restrict circulation of smoke and arranged to close automatically when the system is not in operation.

G. Dedicated smoke detectors or interface to area smoke detectors shall be provided for all smoke and fire/smoke dampers. Special attention is called to smoke and fire/smoke damper actuator interface devices interlocked to the fan coil unit for shutdown in compliance with code. Coordinate with Division 26 for interlock as required.
H. All system shutdowns shall comply with required Building Code, NFPA, Authority Having Jurisdiction, and Fire Marshal requirements.
I. All life safety dampers shall fail to their safe position on loss of power.

1.5 INTENT

A. It is the intent of this Section of the specifications to provide a complete, operable, adjusted Automatic Control and Energy Management System as shown and specified which is free of hunting and excessive cycling.

1.6 SYSTEM ENVIRONMENTAL REQUIREMENTS

A. All control system devices, sensors, controllers, wiring, relays, etc. shall be selected for the environment in which they are installed (indoor, outdoor, ventilated space, etc.). An appropriate enclosure shall be provided where required. Systems installed in return air plenums shall meet ASTM B4E requirements for smoke / flame development.

1.7 ACCEPTABLE MANUFACTURERS

A. Basis of design is the Trane Summit facility management system.
B. Acceptable substitute manufacturers for the automatic controls and BAS are Honeywell (Tridium AX / Niagara platform), Schneider Electric, Carrier, and Automated Logic Controls.

C. The BAS shall be installed by technicians who are either directly employed by the manufacturer or are properly trained technicians in the direct employ of an authorized dealer and installer for the manufacturer.

1.8 OPEN PROTOCOL REQUIREMENTS

A. The new BAS shall utilize an open protocol communication system (BACnet, LonTalk) and shall be an open platform for interface by multiple component suppliers and integrators.
B. The open protocol access shall be to the extent that any control system integrator may access and interface with the BAS without the need for proprietary controller, hardware, software, etc.
C. Common access and integration tools shall be able to be utilized to interface with the system.
D. The system shall not require sole source or proprietary device suppliers.

E. The BAS installer shall indicate any and all proprietary devices in their package that may not meet this requirement in the proposal response. Should proprietary devices or software limit the open protocol concept, that system shall be removed from consideration for this project.

1.9 NEW SYSTEM SOFTWARE UPGRADES

A. Control system software updates shall be included with no additional future cost, annual maintenance agreement, etc. This includes routine program updates for improvements, maintenance, etc. It is not intended to include a major upgrade to a new platform. The intent is to allow for indefinite system operation without required upgrade to a new platform.
B. Project pricing and scope of work descriptions shall be provided to the Owner. The scope description should refer to this specification and state the complete scope included comprehensively. Items excluded shall be outlined in the pricing.

C. Provide unit pricing for terminal unit integration on a per terminal unit basis (PIU and VAV boxes).

D. Provide confirmation of point capacity as required in this specification. Confirmation shall be based on all known projects, including future project upgrades. It is the intent that adequate point capacity be included for reasonable flexibility without the need to add network controllers or other devices on an ongoing basis.

E. The control system shall be submitted to the Owner and Engineer for approval. The submittal shall include all hardware, point list summaries, wiring diagrams, control diagrams, sequence of operation, etc. for the entire system. The submittal shall be a supplement to this specification and included as an attachment to represent the project as-built condition.

PART 2 PRODUCTS

2.1 WEB ACCESSIBLE FACILITY MANAGEMENT SYSTEM

A. The BAS shall be fully accessible from a secure user computer workstation on the Owner network or any station with secured internet connection via a standard web.
B. Software installation and setup shall be by the Controls Contractor on a PC workstation, laptop, or server located as directed by the Owner.
C. Control communication shall be on an independent LonTalk or BACnet network. Control contractor shall review and interface and communication protocol with the Owner's IT representative to gain a full understanding of any communication parameters or interface required to the Owner's network.
D. Any access to the Owner's network shall be coordinated before and during construction.

2.2 MINIMUM STANDARDS

A. BAC Net or Lon compliant per ASHRAE / ANSI standard 135.
B. The BAS shall be capable of controlling multiple building functions such as lighting, alarm systems and HVAC equipment.
C. The BAS shall be modular and shall permit modular expansion of both capacity and functionality through the addition of sensors, actuators, stand-alone DDC panels.
D. The system architecture shall eliminate dependence on any single device for alarm reporting and control execution.
E. The system shall provide global setpoint and schedule modifications and pop-up operation sequence for any device shown by graphic.
F. This Division 23 scope shall include all integration, coordination, programming, etc. for systems and equipment installed as part of the base building scope, as well as pre-programming and integration of typical future systems.

2.3 CENTRAL CONTROL PANEL (CCP)

A. The function of the Central Control Panel (CCP) shall be to provide global commands and data for the Remote Control Panels (RCP) and to allow for remote communication with central server software (see 2.1 above). Provide all required data communication devices for communication between CCP and the fire alarm system. Communication between the server system and CCP is via the Owner's communication network.
B. The CCP shall contain the complete building operating system so that continuous connection to the user workstation is not required for normal operation.
C. The CCP shall contain the system scheduling functions subject to central system software.
D. The CCP battery backed by a self-charging battery system for uninterrupted operation upon power outage. This system shall be capable of all system functions for a minimum of 7 days. The control contractor shall reprogram CCPs shall a memory failure occur during the first five years of system operation. This reprogramming shall be at no cost to the Owner.
E. The CCP shall continuously scan all RCPs and zone control panels (ZCPs) storing field data and alarms to allow for quick retrieval by the central server software.

F. All communication parts for the CCP shall be provided with lightning protection devices. These devices shall include gas discharge diodes and metal oxide varistors and shall be capable of suppressing spikes up to 1000 V in less than 100 nanoseconds.
G. High resolution color graphics shall be provided as described in this specification. These graphics shall be dynamic displaying the most current data on the screen. Set points shall be changeable through these color graphics screens. Provide a manual control menu to allow the Operator to manually turn on or off points, start and stop equipment, manually adjust outputs, restart control calculations, or release points to automatic control.
H. The CCP shall be able to inform the Operator of communication failures between CCPs, CCPs and RCPs and CCP and ZCPs. Statistics on these communications shall be maintained and stored in the CCP to aid in the identification of problems in the communication wiring.

2.4 REMOTE CONTROL PANELS (RCP)

A. Stand-alone Remote Control Panels (RCP) shall be provided on all HVAC system equipment, air handling unit, fan coil unit, etc.
B. RCPs shall be stand-alone controllers responsible for all input/output and local control loop algorithms. Control programs for local control shall be contained in the RCP so that control is maintained should communication with the CCP be lost.
C. The RCP battery backed by a self-charging battery system for uninterrupted operation upon power outage. This system shall be capable of all system functions for a minimum of 7 days. The control contractor shall reprogram CCPs shall a memory failure occur during the first five years of system operation. This reprogramming shall be at no cost to the Owner.

D. Control programs shall be stored in nonvolatile yet changeable EEPROM type memory. Set points for all control loops shall be changeable in the field by the owner using an Contractor provided laptop. Provide all interface devices and software so that these changes can be made. DDC controllers requiring their programs to be downloaded from the CCP are not acceptable.
E. Provide a means for Operator interface to provide local display and adjustment of all inputs, outputs and set points.

2.5 ZONE CONTROL PANELS (ZCP)

A. Zone control panels shall be provided for each terminal unit to provide stand-alone control of that unit. These control shall have point capacity as required to accomplish the specified sequence of operation and point list.
B. ZCP software shall be non-volatile yet changeable EEPROM type memory. Systems using non-changeable ROM or battery backed RAM are not acceptable due to servicing problems.
C. The CCP battery backed by a self-charging battery system for uninterrupted operation upon power outage. This system shall be capable of all system functions for a minimum of 7 days. The control contractor shall reprogram CCPs shall a memory failure occur during the first five years of system operation. This reprogramming shall be at no cost to the Owner.

D. All control devices mounted in the return air plenum including the ZCP shall be UL rated for use in return air plenums. Provide evidence of the UL rating during the submittal process.
E. Controls for the terminal units shall be mounted, wired, and tested by the terminal unit manufacturer. Provide the terminal unit manufacturer with control devices, point-to-point wiring diagrams, and a checkout simulator board to aid in the control installation.

2.6 VARIABLE FREQUENCY DRIVES

A. Variable frequency drives shall be networked to the control system through a network (BACnet, etc) and shall also be hard-wired to the nearest control panel.

2.7 HVAC SYSTEM SENSORS

A. Sensors shall be high accuracy, (plus or minus 0.1%), resistance temperature type.
1. Mixed air sensors shall be of the overvoltage type with a 22-foot minimum element strung evenly across the entering side of the coil bank and securely attached.
2. Discharge air sensors shall be insertion type sensor mounted in a location that will permit measurement of average discharge temperature as tested by the AHJ. Manufacturer or shall be an overvoltage sensor with 20-foot element strung and evenly spaced across the discharge duct.
3. Outside air sensor shall be a mounted in a shaded location in a weatherproof housing.
4. Mixed air low limit thermostat shall be the manual reset type with a minimum 20-foot multi-point sensing element, securely and evenly spaced across the entering side of the coil bank. Provide multiple low limits when coil face area exceeds 16 square feet and factory wire in series.
5. Pressure sensors and remote HVAC system sensors shall be selected for the required environment (duct mounted, plenum rated, etc.).

2.8 ACTUATORS

A. Damper and valve actuators shall be low-voltage electronic, positive positioning, spring return, positive closure, factory selected, mounted and tested for proper operation based on unit size, type, and torque requirements.
B. Coordinate stroke speed, torque, etc. with equipment manufacturer for application.
C. Line voltage (120V) devices shall be provided for actuators that require higher capability than low voltage actuators can provide. Electrical connection shall be coordinated with Division 26.
D. Actuator power shall be provided and installed by the Controls SubContractor and coordinated with Division 26.
E. Rooftop unit outside air damper assembly and its associated damper actuator shall be either Trane TRAQ or Ruskia IAQ.

2.9 ROOM SENSORS AND THERMOSTATS

A. Room sensor and thermostat cover type and color shall be as directed by the Architect. All space temperature sensors shall be provided with a user temperature adjustment wheel or push button, LCD readout, and zone override.
B. Sensors in public spaces shall be thermostat "bypass" type, without screen, user adjustment, or wall box. Coordinate button finish with Architect.
C. Refer to design documents and equipment schedules for specificity area sensor requirements.
D. Thermostats for wall heaters, unit heaters and ventilating fans shall be line-voltage, low-voltage type to control the fans, heaters, etc. indicated. Thermostats shall be single or dual temperature as required for each specific application. Thermostats for heating-only and ventilation-only service shall have adjustable dead-bands to provide at least 3°F between ON and OFF to prevent short-cycling. Dead band dual-temperature thermostats shall be used to control all services having both heating and cooling/ventilating functions. Covers shall be plain with concealed set points.
E. Thermostats shall be located where shown. Where installed on an exterior wall or partition, the sensor shall be provided with an insulated backing to avoid influence by wall cavity temperatures.
F. Thermostat and sensor elevation shall be as directed by the Architect.

2.10 PRESSURE SENSORS

A. Duct static pressure sensors shall be located within the ductwork in a representative location and shall have an installed accuracy of ± 5% over the normal operating range of the sensed medium. These sensors shall be capable of withstanding 200% of the maximum pressure of the system.
2.11 HUMIDITY SENSORS
A. Electronic humidity sensors shall be provided as required to provide installed accuracies of ± 3% from 10 to 90% relative humidity. Humidity sensors shall be capable of recovering from complete saturation without changing calibration point.
B. Space humidity sensors shall be provided with a cover similar to the space sensors with no user adjustment capability. Humidity sensors in lobbies and high finish public areas shall be remote type similar to temperature sensors.
C. Where thermostats and humidity sensors are co-located, they may be a combination sensor meeting the requirements of the applicable sections.

2.12 LIGHTING CONTROLS

A. Lighting control panels provided by Division 26 shall be provided with an interface to the BAS system. This Contractor shall coordinate the necessary requirements with Division 26. All zone control programming shall be by Division 26. BAS system tie-in and on/off control shall not affect lighting control panel programming.

2.13 CONTROL SYSTEM CAPACITY

A. Provisions shall be made for future Tenant system integration. Reasonable future system expansion/integration shall be possible without the need for additional CPUs or main system controllers. Contractor shall review interior system drawings to determine the general scope. Provide a summary scope for accommodating future systems as part of the system submittal.

PART 3 EXECUTION

3.1 INSTALLATION

A. The controls shall be installed in strict accordance with

3.3 SEQUENCES OF OPERATION - This sequence is an outline of the major equipment basic operation.

- A. Rooftop Units
The packaged rooftop units shall be controlled through the control panels and thermostats provided with the rooftop units.
1. During Un-Occupied Mode of operation, and whenever the RTU is off, the outside air dampers shall be closed and admit no outside air.
2. During Occupied Mode of operation, the outside air dampers shall open and shall control, measure, and record the amount of outside air entering thru the OA damper.
3. OA CFM set-point shall be visible to the operator on the Rooftop unit graphic and accessible through the graphical interface for adjustment.
4. During differential enthalpy economizer operation, the rooftop unit controls shall modulate the OA/RA dampers and powered exhaust fan, as applicable, to satisfy building/floor pressure setpoint (adjustable).
5. When the BAS transitions from Un-Occupied to Occupied, the Rooftop unit OA dampers shall be held closed until the morning start-up sequence is completed.
6. During morning warm-up, all PUI system terminal unit air valves shall be driven to maximum.
7. The warm-up cycle shall conclude when the morning warm-up sensor is satisfied.
B. Supply Pressure Reset: The BAS shall identify the system critical VAV zone using damper position and following the procedure described in ASHRAE Standard 90.1 and as restated below:
1. The BAS shall continuously monitor the damper position of all VAV terminal units served by the rooftop system.
2. When any damper is more than 95% (adjustable) open, the supply fan duct static pressure set-point shall be reset upward by 5% (adjustable) of the maximum system static pressure set-point at a frequency of 10 minutes (adjustable) until no damper is more than 95% open or the static pressure set-point has reset upward to the system maximum setting for the supply fan VFD.
3. When all dampers are less than 85% (adjustable) open, the supply fan discharge duct static pressure set-point shall be reset downward by 5% (adjustable) of the maximum system static pressure set-point at a frequency of 10 minutes (adjustable) until any damper is more than 85% open or the static pressure set-point has reset downward to the system minimum setting for the supply fan VFD.
4. The control bands, set-point increment values, set-point decrement values and adjustment frequencies shall be adjusted to maintain maximum static pressure optimization with stable system control and maximum comfort control.
5. Each rooftop system graphic shall identify the current critical zone by tag and display the critical zone primary air damper percent open.
C. Supply Air Temperature Reset: A supply air temperature reset routine shall be provided to adjust temperature set-point in 1F (adjustable) increments
1. The COP shall poll each VAV and PUI terminal served by the air handling unit. If 90% (adjustable) of the terminal units served by the air handling unit are at set point temperature, the duct supply temperature shall be raised by 1F (adjustable) up to a high limit of 65F (adjustable).
2. This routine shall occur at a frequency no more than once every fifteen minutes (adjustable) to avoid continual fluctuations in space temperature.
3. The supply air set point shall return to the original supply air set point if the air handling unit reaches 95% (adjustable) of full capacity.
4. There shall be a User input maximum supply temperature that shall not be exceeded under any condition. The air handling unit graphic shall display the original system set point and the currently operating set point.
D. Zone Overrides
1. Overrides shall be provided so that each zone (terminal unit, heat pump, or air handling unit) may be operated independently whenever the HVAC system is in setback or unoccupied mode.
2. Zone override shall be via a pushbutton on the associated system thermostat.
3. Activation of any override shall enable occupied mode the associate unit on the selected floor, etc. to operate in occupied mode.
4. The activated terminal unit and adjacent terminal units selected by the Owner only shall operate to maintain its thermostat settings. Terminal unit grouping shall be capable of being adjusted by the Owner. As a minimum, if no other direction is given all terminal units in the associated quadrant of the floor shall be activated.
5. The air-handling units and terminal units not activated shall remain in the prior selected mode.
E. Powered Induction Units (PIU)
1. Powered induction units shall have intermittent fan operation (except units serving lobbies, core areas and toilets) and shall modulate primary airflow from 0% (or scheduled minimum) to 100% to maintain the cooling set point (75F, adjustable).
2. Powered induction units serving lobbies, core areas and toilets shall be series type with constant fan operation and shall deliver a constant air quantity to these areas.
C. Split Systems
1. Split systems shall be controlled by a programmable heating/cooling thermostat (set at 70F, adjustable). Units shall be engaged as programmed in coordination with the Owner or 24 hours a day if no direction is given.
2. Space temperature of the machine and controller rooms and run status of the split systems shall be monitored by the BAS system.
H. Electric Heaters
1. Unit heaters shall be controlled by unit-mounted thermostats unless noted otherwise. Thermostats shall be set to energize the unit at 65F set point (adjustable).
2. Wall heaters shall be controlled by an integral electric thermostat. Thermostats shall be set to energize the unit at a 60F set point (adjustable).
3. Duct heaters shall be interlocked with supply fans and shall be controlled by thermostat provided with the supply fan.
I. Fans
1. The toilet exhaust fans shall be energized by the DDC controller. The toilet exhaust fan shall be energized during occupied hours.
2. Unless otherwise noted, all ventilation fans serving electrical and miscellaneous rooms shall be controlled by a thermostat (set at 80F, adjustable). Interlock the associated motor operated dampers to open when the fan is running.
K. Startup
1. Provide the services of a factory trained and qualified service technician employed by the BAS manufacturer who shall inspect the installation including external interlock and power connections; supervise testing, initial operation and calibration of these operating and safety controls.
2. This service technician shall forward a report in four (4) copies to the Owner when the BAS is in safe and proper operating condition. This report shall include all pressure and control settings, during start and run, and shall list minor discrepancies to be corrected that affect safe and reliable operation. One additional copy of the report shall be left in the central control panel. One copy of bound installation, operation, maintenance service and parts brochures, including applicable serial numbers and parts ordering sources, shall be placed in the central control panel at the time of startup; four (4) additional copies shall be forwarded to the Owner.

3.4 CONTROL SYSTEM WIRING

- A. All control system wiring shall be provided and installed by the Controls SubContractor. Coordinate with all trades. This includes line voltage (120V) and low voltage wiring. The voltage wiring shall be installed by a licensed Electrician employed by the Control SubContractor or contracted through the Division 26 SubContractor, under this scope.
B. Coordinate with Division 26 for available circuits for control system power.
C. Coordinate with the Fire Alarm Contractor for life safety system interface including all code required alarms, shut down, fire control panel interface, etc.
D. All control wiring shall be installed in strict compliance with Division 26 specifications.
E. Low voltage wiring in ceiling plenums shall be plenum rated cable and shall be installed in compliance with intended Interior Design Finish throughout all tenant spaces.

3.5 GRAPHICS

- A. Graphics shall be provided for each mechanical system including the all HVAC equipment controlled or monitored by this system and the hot water recirculating pump. Graphics shall show each point that is monitored. Graphics for each piece of equipment shall be indexed by its name. Additional graphics shall show each floor with zone temperatures. If one graphic is not sufficiently large to capture an entire system or floor then it shall be logically separated into two graphics.
B. A graphic for each piece of equipment shall be provided and include all system points monitored or required for system function and user interface.
C. Floor plan graphics shall show all ductwork, diffusers, interior walls, equipment locations, and thermostat locations. Floor plans served by VAV systems shall identify the current critical zone and the current self-contained unit SP setpoints. Functionality of the critical zone reset shall be demonstrated to the Engineer's satisfaction prior to building acceptance.
D. System schematics, risers, flow diagrams, etc. shall be included showing overall system parameters.
E. Electrical risers and floorplans for any and all electrical meters. Coordinate with Division 26.

F. Floorplans for any and all plumbing and mechanical meters, including water meters, irrigation meters, BTU meters, etc.

- G. Provide sketches of proposed graphics for review by the owner to coordinate the design of these graphics. Existing Owner system graphics shall be used if required by the Owner.
H. Graphics for the lighting control shall be independent of the mechanical system floorplans. Lighting control graphics shall include lighting control zones shown on an Architectural floorplan. Similar to the mechanical graphic, the lighting control floorplan graphic shall be updated by each Tenant as appropriate. The lighting control system shall have full integration with the BAS for monitoring and control, as required by the lighting control package.
I. All graphics are subject to the approval of the Owner and shall be submit for review and approval.

3.6 SCHEDULES

- A. All equipment shall be able to be individually scheduled. Coordinate all schedules and breakdowns with the Owner, including for future tenant occupancy.
B. Contractor shall set up all initial schedules and setpoints in coordination with Owner and Commissioning Agent. Schedules and setpoint adjustment shall be included with Owner training.

3.7 OWNER TRAINING

- A. Refer to the general specifications for training requirements. At a minimum, provide the service of a qualified BAS system technician for two (2), 8-hour days for Owner training. The two (2) days shall be non-consecutive and shall be coordinated and scheduled with the Owner and Commissioning Agent, as applicable.

3.8 COMMISSIONING TESTS

- A. Testing of systems/equipment specified in this Section shall be coordinated, scheduled, and documented in accordance with the requirements of commissioning specifications.

3.9 COMMISSIONING DEMONSTRATION

- A. Demonstration of operation and training of Owner's personnel in operation and maintenance of systems/equipment specified in this Section is required. Coordination of the demonstration/training by qualified, factory authorized representatives is required with the Commissioning Authority. Instruction shall include a minimum number of hours as specified herein and approval of the formal training program is required by the Commissioning Authority. Refer to commissioning specifications.

END OF SECTION

LEGEND

Table with 2 columns: Symbol and Description. Includes items like CEILING DIFFUSER, CEILING RETURN AIR GRILLE, SIDE-WALL or DUCT MOUNTED REGISTER, SLOT DIFFUSER, MANUAL VOLUME DAMPER, FIRE DAMPER, THERMOSTAT, HUMIDISTAT, NIGHT SET-BACK, MOTOR OPERATED DAMPER, EXISTING WORK, NEW WORK, WORK TO BE REMOVED, FLOOR DRAIN, HOSE BIBB, FLOOR CLEAN-OUT, WALL CLEAN-OUT, DUCT ACCESS PANEL.

MECHANICAL SUMMARY

Table with 2 columns: Item and Value. Includes Method of Compliance (Prescriptive, Energy cost Budget), Thermal Zone (3A), Interior design conditions (winter dry bulb: 18 deg F, summer dry bulb: 94 deg F), Total tenant heating load (N/A), Total tenant cooling load (N/A), Mechanical Spacing Conditioning System (Unitary), Equipment schedules with motors (mechanical systems) (motor horsepower, number of phases, minimum efficiency, motor type, # of poles).

COMMISSIONING NOTES:

- 1. THE 2018 NC ENERGY CODE REQUIRES THE MECHANICAL AND SERVICE WATER HEATING SYSTEMS IN BUILDINGS WITH A FLOOR AREA IN EXCESS OF 10,000 SQ. FT TO BE COMMISSIONED BY A REGISTERED DESIGN PROFESSIONAL.
2. THE CONTRACTOR SHALL OBTAIN THE SERVICES OF A NC LICENSED ENGINEERING PROFESSIONAL TO PERFORM ALL REQUIRED COMMISSIONING. PRIOR TO ISSUANCE OF CERTIFICATE OF OCCUPANCY A SIGNED STATEMENT OF SYSTEM COMMISSIONING (SEE APPENDIX C1) SHALL BE PROVIDED TO CODE OFFICIAL AND FACILITY OWNER.
3. COMMISSIONING HAS BEEN EXCLUDED FROM BARRETT, WOODYARDS DESIGN SCOPE. HOWEVER, WE CAN PERFORM SAID SERVICES UNDER THE CONTRACTORS SCOPE.
4. COMMISSIONING SHALL BE DONE IN ACCORDANCE WITH SECTION C408 OF THE 2018 NC ENERGY CODE. COMMISSIONING SHALL INCLUDE:
4.1. A COMMISSIONING PLAN WITH:
A) A NARRATIVE OF THE ACTIVITIES TO BE PERFORMED AND BY WHO.
B) A LIST OF EQUIPMENT TO BE COMMISSIONED.
C) FUNCTIONS TO BE TESTED.
D) CONDITIONS UNDER WHICH TESTS SHALL BE PERFORMED.
E) MEASURABLE CRITERIA FOR PERFORMANCE.
4.2. HVAC SYSTEMS SHALL BE TESTED AND BALANCED. REFER TO SPEC SECTION 23043 FOR TEST AND BALANCE REQUIREMENTS.
4.3. HYDRONIC SYSTEMS SHALL BE BALANCED ACCORDING TO THE REQUIREMENTS SET FORTH IN C408.2.2.2.
4.4. ALL CONTROLS SHALL BE COMMISSIONED TO ENSURE ALL SYSTEM ARE OPERATING IN ACCORDANCE WITH APPROVED PLANS AND SPECIFICATIONS.
4.5. FUNCTIONAL TESTING TO ENSURE SYSTEMS ARE OPERATING IN ACCORDANCE WITH APPROVED PLANS AND SPECIFICATIONS.
5. CONTRACTOR SHALL PROVIDE TO THE OWNER AND SYSTEM COMMISSIONING AGENT, ALL INSTRUCTIONS ON MAINTENANCE AND OPERATION OF ALL SYSTEMS AND EQUIPMENT. THE DOCUMENTATION SHALL INCLUDE THE FOLLOWING, AT A MINIMUM:
A) SUBMITTAL DATA
B) OPERATION AND MAINTENANCE MANUALS FROM MANUFACTURER.
C) NAME AND ADDRESS OF AT LEAST ONE SERVICE AGENCY.
D) CONTROL SYSTEM MAINTENANCE AND CALIBRATION INFORMATION.
E) TEST & BALANCE REPORT
6. CONTRACTOR TO PROVIDE AT PROJECT COMPLETION, PRIOR TO OBTAINING CERTIFICATE OF OCCUPANCY, PRESENT AT FINAL INSPECTION TO THE JURISDICTION'S AHJ A SIGNED AND DATED STATEMENT OF SYSTEM COMMISSIONING FOR ALL MECHANICAL & HYDRONIC SYSTEMS. THE FORMAT OF THE STATEMENT OF SYSTEMS COMMISSIONING SHALL BE IN THE FORM REQUIRED BY THE STATE'S ENERGY CONSERVATION CODES AND/OR AHJ REQUIREMENTS. THE DOCUMENT SHALL BE SIGNED BY THE CONTRACTOR'S LICENSED PROFESSIONAL ENGINEER REPRESENTATIVE.

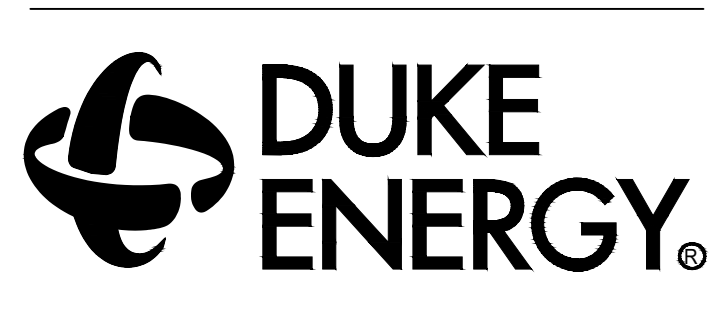
ABBREVIATIONS

Table with 2 columns: Abbreviation and Full Name. Includes A/C ABOVE CEILING ACCESS DOOR, AFF ABOVE FINISHED FLOOR, AUTO AUTOMATIC, AC AIR CONDITIONING, AHU AIR HANDLING UNIT, BAL BALANCING, BOD BACKDRAFT DAMPER, B/F BELOW FLOOR, B/G BELOW GRADE, B'FLY BUTTERFLY BRAKE, BHP HORSEPOWER, BCD BREAK CLEANOUT, CFM CUBIC FEET PER MINUTE, CBRV CURVED BLADE CEILING REGISTER, CD CEILING DIFFUSER, CU CONDENSING UNIT, CW COLD WATER (DOMESTIC), CHWS CHILLED WATER SUPPLY, CHWR CHILLED WATER RETURN, CON CONDENSER WATER SUPPLY, CWR CONDENSER WATER RETURN, CON CONCENTRIC CLEANOUT, CO CONDENSATE, db DRY BULB, DN DOWN, DR DRAIN, dt DITO, db DECIBELS, DWG DRAWING, EA EACH, EAT ENTERING AIR TEMPERATURE, ECC ECCENTRIC, EF EXHAUST FAN, EOD EMERGENCY OVERFLOW DRAIN, ER EXHAUST REGISTER, ESP EXTERNAL STATIC PRESSURE, EWP ENTERING WATER TEMPERATURE, EXH EXHAUST EFFICIENCY, EFF EFFICIENCY, FCU FAN COIL UNIT, FSD FIRE/SMOKE DAMPER, FD FIRE DAMPER OR FLOOR DRAIN, FL DR FLOOR DRAIN (only), FLR FLOOR, FOB FLAT ON BOTTOM, FOR FUEL OIL RETURN, FOS FUEL OIL SUPPLY, FOT FLAT ON TOP, FFM FEET PER MINUTE, FFS FEET PER SECOND, FT FEET, G GATE, GA GAUGE, GPM GALLONS PER MINUTE, GL GLOBE, GCO GRADE CLEANOUT, HD HUB DRAIN, HP HORSEPOWER, HTG HEATING, HW HOT WATER (DOMESTIC), HWR HOT WATER RETURN, HWRR HOT WATER REVERSE RETURN, HWS HOT WATER SUPPLY, HZ HERTZ, V VENT, VALVE, VTR VENT THRU ROOF, VAV VARIABLE AIR VOLUME, wb WET BULB, WC WATER COLUMN, WHA WATER HAMMER ARRESTOR, WT WEIGHT, W WASTE, SP STATIC PRESSURE, SPS STATIC PRESSURE SENSOR, SA SUPPLY AIR, SAN SANITARY, SD SMOKE DAMPER, SEN SENSIBLE, SQ SQUARE, SR SUPPLY REGISTER, ST STORM, SS SPLIT SYSTEM, TEMP TEMPERATURE, TG TRANSFER GRILLE, TYP TYPICAL, UON UNLESS OTHERWISE NOTED.

GENERAL NOTES (APPLY TO ALL SHEETS)

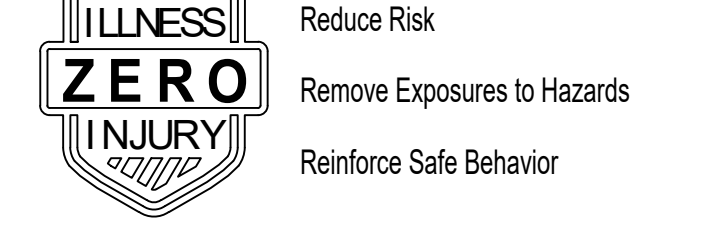
- 1. THESE DRAWINGS ARE SCHEMATIC IN NATURE AND ARE NOT INTENDED TO SHOW ALL POSSIBLE CONDITIONS. IT IS INTENDED THAT A COMPLETE TENANT MECHANICAL SYSTEM BE PROVIDED WITH ALL NECESSARY EQUIPMENT, ACCESSORIES, OPTIONS AND CONTROLS, COMPLETELY COORDINATED WITH ALL DISCIPLINES. ALL ITEMS AND LABOR REQUIRED FOR A COMPLETE TENANT MECHANICAL SYSTEM IN ACCORDANCE WITH ALL APPLICABLE CODES, STANDARDS AND THE BASE BUILDING CONTRACT DOCUMENTS SHALL BE FURNISHED WITHOUT INCURRING ADDITIONS TO THE CONTRACT.
2. REFER TO THE ARCHITECTURAL DRAWINGS FOR EXACT PARTITION LAYOUTS, REFLECTED CEILING PLANS, DIMENSIONS, ETC.
3. COORDINATE THE LOCATION OF ALL TERMINAL UNITS (NEW & EXISTING) CLOSELY WITH ALL WALLS THAT GO TO STRUCTURE, COLUMNS, DUCTWORK, ETC. THE UNIT SHALL EITHER BE RELOCATED OR THE WALL OFFSET TO PROVIDE CLEARANCE THE UNIT SHALL HAVE THE GREATER OF 2'-0" OF SERVICE CLEARANCE ALL AROUND OR AS REQUIRED BY CODE.
4. REFER TO THE ARCHITECTURAL REFLECTED CEILING PLANS FOR EXACT LOCATIONS OF ALL CEILING MOUNTED AIR DISTRIBUTION DEVICES. IF ANY ITEMS ARE NOT SHOWN ON THE REFLECTED CEILING PLANS, PREPARE A DRAWING OF THE PROPOSED LOCATION AND PRESENT IT TO THE ARCHITECT FOR APPROVAL PRIOR TO INSTALLATION.
5. ALL ROUND AND FLEXIBLE DUCTWORK EXTENDING TO DIFFUSERS SHALL BE SIZED FULL SIZE OF DISTRIBUTION DEVICE INLET, AND TAPS TO THE EXISTING LOW-PRESSURE DUCTWORK SHALL BE MADE WITH SPIN-IN FITTINGS HAVING INTEGRAL SCOOPS AND VOLUME DAMPERS. ALL NEW RECTANGULAR DUCTWORK TAPS SHALL BE MADE WITH SPLITTERS OR EXTRACTORS. ALL DUCTWORK SHALL BE CONSTRUCTED AND INSTALLED IN ACCORDANCE WITH SMACNA DUCT STANDARDS. NEW LOW PRESSURE SPIN-IN FITTINGS AND TAPS SHALL NOT BE MADE WITHIN 5 FT OF OUTLET OF EQUIPMENT. NEW LOW PRESSURE SPIN-IN FITTINGS SHALL BE MADE NO CLOSER THAN 2'-0" ON CENTER.
6. FLEXIBLE DUCTS SHALL BE INSTALLED FREE OF SAGS AND KINKS, SUPPORTED AT NOT MORE THAN 48" O.C.
7. TEST AND BALANCE ALL DIFFUSERS, BOXES, FANS, ETC. TO THE AIRFLOWS AND CONDITIONS INDICATED. ALL EXISTING DIFFUSERS, BOXES, FANS, ETC. WHICH ARE NOT THEIR OTHER DESIGN AIRFLOWS, REFERENCE THE EXISTING RECORD DRAWING AVAILABLE FROM THE OWNER. TESTING AND BALANCING OF HVAC SYSTEM SHALL BE PERFORMED IN ACCORDANCE WITH THE STANDARDS OF ASHRAE OR NEBB AND SHALL BE PERFORMED UNDER THE DIRECT SUPERVISION OF AN ASHRAE OR NEBB CERTIFIED TEST AND BALANCE ENGINEER. SUBMIT 4 COPIES OF THE REPORT TO THE OWNER.
8. NEW PERIMETER SLOT DIFFUSERS SHALL BE PROVIDED AS REQUIRED, AND SELECTED IN ACCORDANCE WITH BASE BUILDING STANDARD.
9. PORTIONS OF DUCTWORK VISIBLE THROUGH GRILLES AND REGISTERS IN FINISHED AREA SHALL BE PAINTED FLAT BLACK.
10. ALL CONTROL WIRING AND TUBING INSTALLED ABOVE THE CEILING SHALL BE LOCATED AS HIGH ABOVE THE CEILING AS POSSIBLE AND SHALL FOLLOW THE DESIGNATED GENERAL ROUTING OF THE DUCTWORK. DO NOT HANG WIRING OR TUBING FROM DUCTWORK; RATHER, SUSPEND FROM THE STRUCTURE. ALL NEW TERMINAL UNITS SHALL BE TIED INTO THE BASE BUILDING CONTROL SYSTEM. SEE BASE BUILDING SPECIFICATIONS FOR REQUIREMENTS.
11. SPRINKLER HEADS AND ASSOCIATED BRANCH PIPING SHALL BE PROVIDED AND RELOCATED IN ACCORDANCE WITH NFPA 13 AND ALL PREVAILING LOCAL CODES AS REQUIRED TO PROTECT ALL SPACES IN THIS TENANT AREA. SPRINKLER HEADS SHALL BE SEMI-RECESSED SPRINKLER HEADS IN TENANT AREAS AND CONCEALED FULLY RECESSED TYPE IN PUBLIC CORRIDORS.
12. COORDINATE ALL WORK IN OCCUPIED AREAS WITH THE TENANT IN THAT AREA. COORDINATE ALL WORK IN UNOCCUPIED AREAS AND COMMON AREAS WITH LANDLORD.
13. ALL MATERIALS IN PLENUM SHALL BE PLENUM-RATED.
14. THERMOSTATS SHALL BE LOCATED IN EACH ZONE AS SHOWN. THE EXACT LOCATION ON THE WALL INDICATED SHALL BE AS DIRECTED BY THE ARCHITECT. NEW THERMOSTATS SHALL BE SELECTED TO MATCH EXISTING BASE BUILDING THERMOSTATS AND SHALL BE COMPATIBLE WITH EQUIPMENT SERVED. THERMOSTATS ON EXTERIOR WALLS SHALL BE PROVIDED WITH INSULATED BACKING.
15. MATERIALS EXPOSED WITHIN THE PLENUM SHALL BE NONCOMBUSTIBLE OR HAVE A FLAME SPREAD INDEX OF NOT MORE THAN 25 AND A SMOKE-DEVELOPMENT INDEX OF NOT MORE THAN 50 AS DETERMINED IN ACCORDANCE WITH ASTM E 84.

DRAWING NO. CFD-XXX-M-0005-XXXXXX



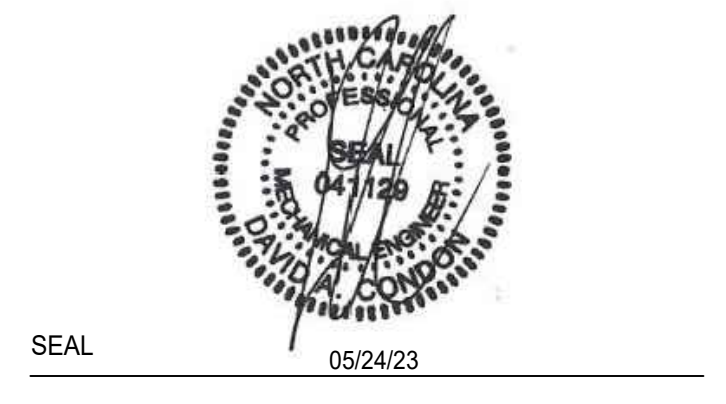
MAILING ADDRESS: P.O. BOX 1007 CHARLOTTE, NC 28201

Safety Expectations:



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DUNN OPERATIONS CENTER

1269 JONESBORO RD. HARNETT COUNTY, NC 28334

OPERATIONS BUILDING

Table with 4 columns: MARK, DATE, REVISION, ISSUED FOR CONSTRUCTION. Includes revision history for the drawing.

PROJECT NO: DRAWING NUMBER CFD-XXX-M-0005-XXXXXX ELECTRONIC FILE NAME: M0001.DWG DRAWN BY: TAYLOR SUBER CHKD BY: DAVID WOODARD E-MAIL: DCONDON@barrettwoodyard.com

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SHEET TITLE: SPECIFICATIONS NOTES & ABBREVIATIONS - MECHANICAL

SHEET NO. M-0005



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### FAN SCHEDULE

I.D. TAG	CAPACITY (CFM)	S.P. (IN. WG)	MOTOR H.P.	DRIVE	VOLTS/PHASE	MAXIMUM FAN RPM	MAXIMUM NOISE	TYPE OF FAN	BASIS OF DESIGN	REMARKS
BAF-A	-	-	1.0	DIRECT	460/3	110	< 55 dBA	BIG CEILING FAN	BIG ASS FAN BASIC 6 (10 FOOT)	⑤
EF-A	6,000	0.3	2.0	DIRECT	460/3	1,175	13.7 SONES	INLINE EXHAUST	GREENHECK SQ-20-07-0700-VG	②③④
TEF-1	1,050	0.5	0.25	DIRECT	115/1	1566	9.2 SONES	INLINE FAN	GREENHECK SQ-100-VG	①②③
EF-B	2,200	0.3	.25	DIRECT	115/1	1,160	18.9 SONES	AXIAL FAN	GREENHECK AER-24	②③④

- ① INTERLOCK FAN WITH RESTROOM LIGHTS.
- ② PROVIDE FAN WITH A SPEED CONTROLLER AND BACKDRAFT DAMPER.
- ③ FAN TO BE TIED INTO CARBON MONOXIDE/NITROGEN DIOXIDE DETECTOR.
- ④ PROVIDE FAN WITH A WALL MOUNTED SWITCH.
- ⑤ PROVIDE FAN WITH STANDARD WALL MOUNTED ON/OFF SWITCH/SPEED CONTROLLER.

### PACKAGED (GROUND BASED) ROOF TOP UNIT SCHEDULE

I.D. TAG	MINIMUM TOTAL CAP. (MBH)	MINIMUM SENSIBLE CAP. (MBH)	AMBIENT TEMP. (°F)	COIL EAT		AIRFLOW (CFM) ③	EXT. S.P. (IN. W.C.) ①	MAX BHP.	OUTSIDE AIR (CFM)		HEATING SECTION		VOLTS/PHASE	MCA	MOCP	BASIS OF DESIGN	EER	APPROX. UNIT WEIGHT (LBS)	REMARKS
				°F db	°F wb				MINIMUM	MAX	TYPE	CAPACITY							
RTU-1	320.50	234.88	95.0	76.0	64.0	12,000	2.5	13.45	1,850	2,000	ELEC	54 kW	460/3	103.02	110.0	TRANE TEH360C4B	11.3 EER	4,800	②③④⑤⑥⑦⑧⑨⑩⑪

- ① THIS IS THE STATIC PRESSURE EXTERNAL TO THE UNIT. IT DOES NOT INCLUDE COIL, CASING, FILTER OR HEATER LOSSES.
- ② PROVIDE UNIT COMPLETE FACTORY DISCONNECT W/ LOCKOUT PROTECTION CAPABILITY.
- ③ SUPPLY FAN SHALL BE CAPABLE OF SUPPLYING AIRFLOW AT CFM & E.S.P. (IN. W.C.) AS INDICATED ON SCHEDULED ABOVE.
- ④ PROVIDE WITH HAIL GUARD.
- ⑤ PROVIDE SMOKE DETECTOR IN RETURN. INSTALLATION SHALL BE IN ACCORDANCE WITH NFPA 72E. COORD. W/ DIVISION 16.
- ⑥ POWERED WEATHERPROOF GFI DEDICATED CONVENIENCE OUTLET TO BE PROVIDED, COORDINATE WITH ELECTRICAL.
- ⑦ PROVIDE UNIT WITH FULLY MODULATING DIFFERENTIAL ENTHALPY ECONOMIZER.
- ⑧ PROVIDE UNIT WITH CO2 SENSOR LOCATED IN THE RETURN OF THE UNIT. SENSOR SHALL BE TIED INTO ECONOMIZER AND MODULATE THE OUTSIDE AIR BETWEEN MINIMUM AND MAXIMUM OUTSIDE AIR VALUES. REFER TO OA TABLE.
- ⑨ PROVIDE UNIT WITH POWERED EXHAUST FAN.
- ⑩ PROVIDE UNIT WITH VAV CONTROLS.
- ⑪ PROVIDE UNIT WITH HOT GAS BYPASS.
- ⑫ PROVIDE WITH DUAL COMPRESSORS.
- ⑬ PROVIDE WITH HOT-GAS BYPASS HUMIDITY CONTROL.

### SPLIT SYSTEM SCHEDULE

I.D. TAG	MINIMUM TOTAL CAP. (BTUH)	MINIMUM SENSIBLE CAP. (BTUH)	AIRFLOW (CFM)	OUTSIDE AIR (CFM)	EXT. S.P. (IN. W.C.) ①	MAX H.P.	FAN COIL UNIT DATA		TYPE OF UNIT	HEATING SECTION TYPE	CAPACITY	CONDENSING UNIT DATA			BASIS OF DESIGN	REMARKS			
							°F db	°F wb				AMBIENT TEMP. (°F)	VOLTS/PHASE	STAGES			MIN. SEER		
AHU-1/CU-1	24,000	---	775	---	---	---	80	67	208/1 D	1075	WALL MOUNTED	HP	26,000	95	208/1	VFD	21.4	MITSUBISHI PKA-A24KA7/PUZ-A24NHAT	④⑤⑥
AHU-2/CU-2	24,000	---	775	---	---	---	80	67	208/1 D	1075	WALL MOUNTED	---	---	95	208/1	VFD	21.4	MITSUBISHI PKA-A24KA7/PUZ-A24NHAT	④⑤⑥

- ① THIS IS THE SP EXTERNAL TO THE ENTIRE FAN COIL UNIT ASSEMBLY (WET COIL, CASING, CLEAN FILTERS, AND FURNACE LOSSES ARE NOT INCLUDED IN THIS EXT. SP.)
- ② B = BELT DRIVE, D = DIRECT
- ③ HP STANDS FOR HEAT PUMP AND CAPACITY IS GIVEN IN MBH, ELEC STANDS FOR ELECTRIC HEAT AND VALUES ARE GIVEN IN KW.
- ④ PROVIDE WITH REMOTE WALL MOUNTED FULLY PROGRAMMABLE THERMOSTAT LOCATED AS SHOWN ON PLANS.
- ⑤ PROVIDE WITH CONDENSATE PUMP, PER MANUFACTURERS RECOMMENDATIONS.
- ⑥ PROVIDE WITH LOW AMBIENT CONTROLS.

### ELECTRIC HEATER SCHEDULE

I.D. TAG	DESCRIPTION	CAPACITY KW	MIN CFM	VOLTS/PHASE	BASIS OF DESIGN	REMARKS
UH-A	FAN FORCED HEATER	13.0	800	460/3	REDDI UH	①
UH-B	FAN FORCED HEATER	5.0	400	460/3	REDDI UH	①

- ① PROVIDE HEATER WITH UNIT MOUNTED THERMOSTAT AND INTEGRAL DISCONNECT.

### 1ST FLOOR TERMINAL UNIT SCHEDULE

Equipment Info		Air Valve Data			Fan Data		Heating Coil Data					Weight Lbs (1)	Basis of Design	Remarks			
TAG	Type	Cooling CFM	Inlet Size	Valve Min	Max ΔP	Fan Min	Fan %	Fan CFM	Max SP (IN WC)	Motor HP	Voltage/Phase				LAT	Design KW	Voltage/Phase
1st Floor																	
P-1	Parallel	640	8"	105	0.45	120	70%	450	0.45	1/3	277/1	90°F	4.0	277/1	40	130	Trane VPEF 2.3
P-2	Parallel	625	8"	105	0.45	120	70%	440	0.45	1/3	277/1	90°F	4.0	277/1	40	130	Trane VPEF 2.3
P-3	Parallel	980	10"	165	0.45	120	70%	690	0.45	1/2	277/1	90°F	6.5	460/3	40	130	Trane VPEF 2.3
P-4	Parallel	825	8"	105	0.45	120	70%	490	0.45	1/3	277/1	90°F	6.0	277/1	40	130	Trane VPEF 2.3
P-5	Parallel	895	10"	165	0.45	120	70%	630	0.45	1/2	277/1	90°F	6.0	460/3	40	130	Trane VPEF 2.3
P-6	Parallel	930	10"	165	0.45	120	70%	655	0.45	1/2	277/1	90°F	6.0	460/3	40	130	Trane VPEF 2.3
P-7	Parallel	430	6"	60	0.45	120	70%	305	0.45	1/3	277/1	90°F	2.5	277/1	40	130	Trane VPEF 2.3
P-8	Parallel	720	10"	165	0.45	120	70%	505	0.45	1/3	277/1	90°F	5.0	460/3	40	130	Trane VPEF 2.3
P-9	Parallel	870	10"	165	0.45	120	70%	610	0.45	1/2	277/1	90°F	5.5	460/3	40	130	Trane VPEF 2.3
P-10	Parallel	350	6"	60	0.45	120	70%	245	0.45	1/3	277/1	90°F	2.0	277/1	40	130	Trane VPEF 2.3
P-11	Parallel	2,225	14"	320	0.45	330	70%	1560	0.45	1	277/1	90°F	14.0	460/3	40	200	Trane VPEF 2.3, 4
P-12	Parallel	1,300	12"	240	0.45	250	70%	910	0.45	1	277/1	90°F	8.0	460/3	40	130	Trane VPEF 2.3
P-13	Parallel	1,300	12"	240	0.45	250	70%	910	0.45	1	277/1	90°F	8.0	460/3	40	130	Trane VPEF 2.3

- (1) WEIGHTS ARE APPROXIMATE. COORDINATE ACTUAL EQUIPMENT WEIGHT WITH STRUCTURAL SUPPORT.
- (2) MAX INLET VELOCITY SHALL BE 2200 FEET PER MINUTE.
- (3) PROVIDE UNIT WITH SINGLE ELECTRICAL CONNECTION, UNIT DISCONNECT AND MERV 8 FILTERS. INSTALL PER MANUFACTURERS RECOMMENDATIONS FOR SERVICE AND ELECTRICAL CLEARANCES.

### Ventilation Sizing Summary for RTU-1

Project Name: 2022-0632 DUNN OPS CENTER  
Prepared by: Barnett Woodyard & Associates

**1. Summary**  
Ventilation Sizing Method: ASHRAE Std 62.1-2016  
Design Condition: Heating operation  
Occupant Diversity (D): 1.000  
Uncorrected Outdoor Air Intake (Vou): 1468 CFM  
System Ventilation Efficiency (Ev): 0.800  
Outdoor Air Intake (Vot): 1835 CFM ①

**2. Space Ventilation Analysis**

Zone Name / Space Name	Mult.	Minimum Supply Air (CFM) (Vpz)	Space Floor Area (A <sub>f</sub> ) (A <sub>z</sub> )	Area Outdoor Air Rate (CFM/ft <sup>2</sup> ) (Ra)	Time Averaged Occupancy (Occupants) (Pz)	People Outdoor Air Rate (CFM/person) (Rp)	Air Distribution Effectiveness (Ez)	Space Outdoor Air (CFM) (Voz)	Breathing Zone Outdoor Air (CFM) (Vbz)	Space Ventilation Efficiency (Evz)
<b>Zone 1</b>										
EXT_3 CREW	1	102	530.0	0.06	10.0	5.00	0.8	102	80	0.800
<b>Zone 2</b>										
EXT_5 CORRIDOR	1	5	72.0	0.06	0.0	0.00	0.8	5	4	0.800
INT_32 STORAGE	1	5	70.0	0.06	0.0	0.00	0.8	5	4	0.800
INT_33 AV	1	3	35.0	0.06	0.0	0.00	0.8	3	2	0.800
INT_29 CORRIDOR	1	33	446.0	0.06	0.0	0.00	0.8	33	27	0.800
INT_30 CORRIDOR	1	36	485.0	0.06	0.0	0.00	0.8	36	29	0.800
INT_38 CORRIDOR	1	39	525.0	0.06	0.0	0.00	0.8	39	32	0.800
<b>Zone 3</b>										
EXT_7 TOWNHALL	1	496	1116.0	0.06	66.0	5.00	0.8	496	397	0.800
EXT_6 STORAGE	1	6	83.0	0.06	0.0	0.00	0.8	6	5	0.800
<b>Zone 4</b>										
EXT_8 PANTRY	1	232	670.0	0.12	21.0	5.00	0.8	232	183	0.800
EXT_9 ENTRY	1	6	74.0	0.06	0.0	0.00	0.8	6	4	0.800
<b>Zone 5</b>										
EXT_10 LARGE CONFERENCE	1	89	357.0	0.06	10.0	5.00	0.8	89	71	0.800
<b>Zone 6</b>										
EXT_11 OFFICE	1	16	124.0	0.06	1.0	5.00	0.8	16	12	0.800
EXT_12 OPEN OFFICE	1	24	152.0	0.06	2.0	5.00	0.8	24	16	0.800
<b>Zone 7</b>										
EXT_13 OPEN OFFICE	1	48	307.0	0.06	4.0	5.00	0.8	48	30	0.800
EXT_14 PRINTER/COPY	1	10	139.0	0.06	0.0	0.00	0.8	10	8	0.800
EXT_15 OFFICE	1	15	122.0	0.06	1.0	5.00	0.8	15	12	0.800
EXT_16 OFFICE	1	15	122.0	0.06	1.0	5.00	0.8	15	12	0.800
EXT_17 CORRIDOR	1	5	72.0	0.06	0.0	0.00	0.8	5	4	0.800
<b>Zone 8</b>										
EXT_18 CREW	1	148	721.0	0.06	15.0	5.00	0.8	148	118	0.800
<b>Zone 9</b>										
INT_23 CREW	1	104	550.0	0.06	10.0	5.00	0.8	104	83	0.800
<b>Zone 10</b>										
INT_24 CREW	1	104	550.0	0.06	10.0	5.00	0.8	104	83	0.800
<b>Zone 11</b>										
INT_25 WELLNESS	1	14	106.0	0.06	1.0	5.00	0.8	14	11	0.800
INT_26 JANITOR	1	10	130.0	0.06	0.0	0.00	0.8	10	8	0.800
INT_27 UNISEX SHOWER	0	0	112.0	0.00	0.0	0.00	0.8	0	0	0.800
INT_28 CORRIDOR	1	33	439.0	0.06	0.0	0.00	0.8	33	26	0.800
INT_30 CORRIDOR	1	36	485.0	0.06	0.0	0.00	0.8	36	29	0.800
INT_34 WOMEN RR	1	0	220.0	0.00	0.0	0.00	0.8	0	0	0.800
INT_35 MEN RR	1	0	413.0	0.00	0.0	0.00	0.8	0	0	0.800
<b>Zone 12</b>										
INT_36 MED CONF	1	72	292.0	0.06	8.0	5.00	0.8	72	59	0.800
<b>Zone 13</b>										
INT_37 FOCUS	1	12	75.0	0.06	1.0	5.00	0.8	12	10	0.800
INT_39 CORRIDOR	1	18	243.0	0.06	0.0	0.00	0.8	18	15	0.800
INT_41 OFFICE	1	15	120.0	0.06	1.0	5.00	0.8	15	12	0.800
INT_42 OFFICE	1	15	120.0	0.06	1.0	5.00	0.8	15	12	0.800
INT_43 OFFICE	1	15	120.0	0.06	1.0	5.00	0.8	15	12	0.800
INT_44 OFFICE	1	15	120.0	0.06	1.0	5.00	0.8	15	12	0.800
INT_45 CORRIDOR	1	25	334.0	0.06	0.0	0.00	0.8	25	20	0.800
INT_40 PHONE	1	10	55.0	0.06	1.0	5.00	0.8	10	8	0.800
<b>Totals (incl. Space Multipliers)</b>		<b>1835</b>							<b>1468</b>	<b>0.800</b>

### Ventilation Sizing Summary for RTU-2

Project Name: 2022-0632 DUNN OPS CENTER  
Prepared by: Barnett Woodyard & Associates

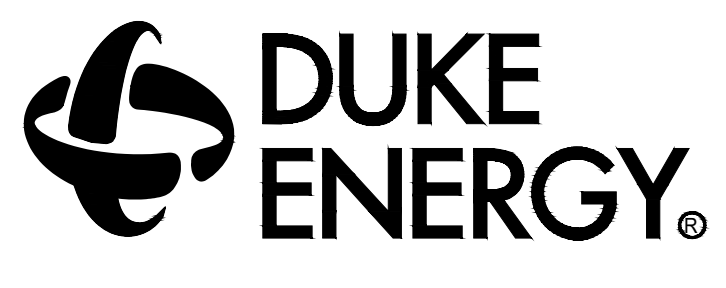
**1. Summary**  
Ventilation Sizing Method: ASHRAE Std 62.1-2016  
Design Condition: Heating operation  
Occupant Diversity (D): 1.000  
Uncorrected Outdoor Air Intake (Vou): 172 CFM  
System Ventilation Efficiency (Ev): 0.970  
Outdoor Air Intake (Vot): 177 CFM ①

**2. Space Ventilation Analysis**

Zone Name / Space Name	Mult.	Supply Air (CFM) (Vpz)	Space Floor Area (A <sub>f</sub> ) (A <sub>z</sub> )	Area Outdoor Air Rate (CFM/ft <sup>2</sup> ) (Ra)	Time Averaged Occupancy (Occupants) (Pz)	People Outdoor Air Rate (CFM/person) (Rp)	Air Distribution Effectiveness (Ez)	Space Outdoor Air (CFM) (Voz)	Breathing Zone Outdoor Air (CFM) (Vbz)	Space Ventilation Efficiency (Evz)
<b>Zone 1</b>										
EXT_1 CORRIDOR	1	58	78.0	0.06	0.0	0.00	0.8	6	5	0.990
EXT_2 STORAGE	1	366	532.0	0.06	0.0	0.00	0.8	40	32	0.982
INT_21 STORAGE	1	299	483.0	0.06	0.0	0.00	0.8	36	29	0.970
INT_22 STORAGE	1	299	483.0	0.06	0.0	0.00	0.8	36	29	0.970
EXT_19 STORAGE	1	352	476.0	0.06	0.0	0.00	0.8	36	29	0.989
EXT_20 CORRIDOR	1	60	73.0	0.06	0.0	0.00	0.8	5	4	1.000
INT_46 CORRIDOR	1	460	743.0	0.06	0.0	0.00	0.8	56	45	0.970
<b>Totals (incl. Space Multipliers)</b>		<b>1895</b>							<b>172</b>	<b>0.970</b>

OUTSIDE AIR CALCULATION/TABLE NOTES:  
(APPLY THIS SHEET ONLY)

① BALANCE OUTSIDE AIR SYSTEM SERVING THE SPACE TO PROVIDE, AT A MINIMUM, THE OUTSIDE AIR RATE INDICATED. THE ASHRAE 2016 OA CALCULATION USED ABOVE IS CALCULATED THE SAME WAY AS FOUND IN THE NC MECHANICAL CODE.



MAILING ADDRESS:  
P.O. BOX 1007  
CHARLOTTE, NC 28201

Safety Expectations:





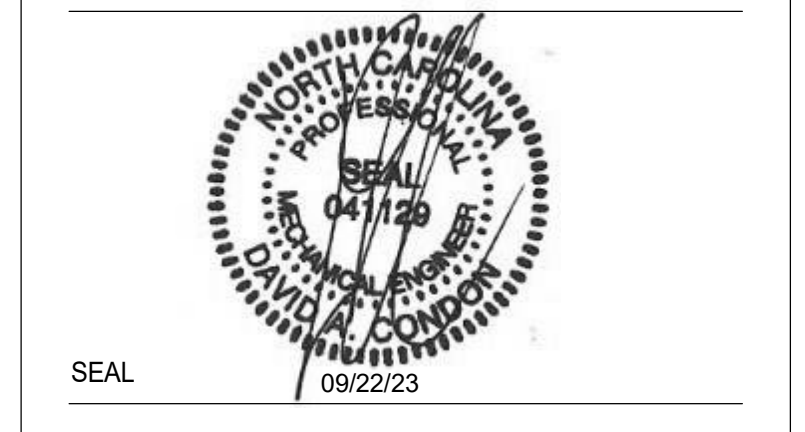
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CHARLOTTE, NC 28201

**Safety Expectations:**  

 Reduce Risk  
 Remove Exposures to Hazards  
 Reinforce Safe Behavior



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**DUNN OPERATIONS CENTER**

1269 JONESBORO RD.  
HARNETT COUNTY, NC 28334

**OPERATIONS BUILDING**

MARK	DATE	DRN BY	REVISION
1	09.22.23		ISSUED FOR CONSTRUCTION
2	05.24.23		
3			
4			
5			
6			
7			
8			
9			
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12			
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14			

PROJECT NO: 9900019.00  
DRAWING NUMBER

**CFD-XXX-M-101-XXXXX**

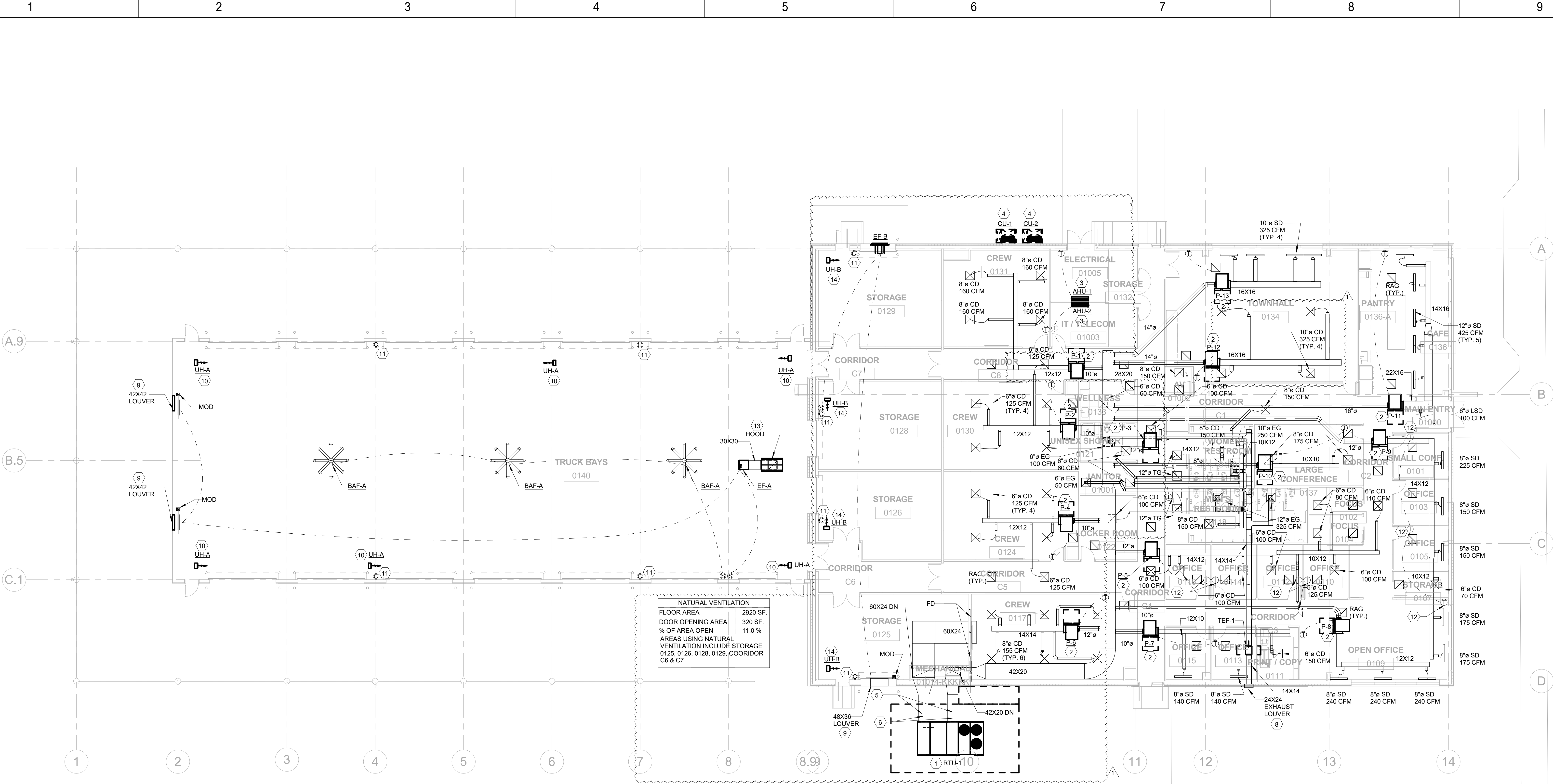
ELECTRONIC FILE NAME:  
DRAWN BY: Author

CHKD BY: Checker DATE:

E-MAIL:  
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SHEET TITLE:  
**FIRST FLOOR PLAN - MECHANICAL**

SHEET NO.  
**M-101**



**NATURAL VENTILATION**

FLOOR AREA	2920 SF.
DOOR OPENING AREA	320 SF.
% OF AREA OPEN	11.0 %
AREAS USING NATURAL VENTILATION INCLUDE STORAGE 0125, 0126, 0129, CORRIDOR C6 & C7.	

**1 FIRST FLOOR PLAN - MECHANICAL**  
M-101 / 3/32" = 1'-0"

**GENERAL NOTES**  
(APPLY TO ALL SHEETS)

- EXACT LOCATION OF ALL AIR DISTRIBUTION DEVICES SHALL BE COORDINATED WITH THE ARCHITECTURAL RCP.
- MATERIALS EXPOSED WITHIN THE PLENUM SHALL BE NONCOMBUSTIBLE OR HAVE A FLAME SPREAD INDEX OF NOT MORE THAN 25 AND A SMOKE-DEVELOPMENT INDEX OF NOT MORE THAN 50 AS DETERMINED IN ACCORDANCE WITH ASTM E 84.
- REPAIR AND REPLACE ANY DUCTWORK THAT DOES NOT MEET SPECIFICATION SECTION 23940. SEAL ANY HOLES IN DUCTWORK AIRTIGHT WITH SHEET METAL AND "HARDCAST."
- COORDINATE THE EXACT LOCATION OF ALL THERMOSTATS WITH FINAL FURNITURE LAYOUT. EQUIPMENT LAYOUT, ARCH AND OWNERS REPRESENTATIVE. CONTRACTOR SHALL TIE NEW T'STATS INTO BUILDING EMS AND UPDATE ACCORDINGLY.
- PROVIDE ALL MANUFACTURER AND NEC REQUIRED CLEARANCE FOR ALL EQUIPMENT.
- RELOCATE ALL SPRINKLER AND PLUMBING PIPING AS REQUIRED TO ACCOMMODATE NEW EQUIPMENT.
- AIR QUANTITIES AS SHOWN SHALL BE USED TO BALANCE SYSTEM PER NEW LAYOUT. CONTRACTOR SHALL VERIFY ACTUAL CAPACITY (CFMs) OF THE EXISTING UNIT AND DISTRIBUTE THEM PROPORTIONALLY TO CFMs SHOWN TO ALL DIFFUSERS.
- ALL THERMOSTATS LOCATED ON EXTERIOR WALLS SHALL BE PROVIDED WITH INSULATED BACKING.
- CONTRACTOR SHALL COORDINATE FINAL LOCATION OF BUILDING EMS WITH OWNERS REP. CURRENTLY DESIGNED TO GO IN THE JANITOR'S CLOSET.

**KEY NOTES**  
(APPLY THIS SHEET ONLY)

- REFER TO 31M-0006 FOR RTU INSTALLATION DETAIL.
- REFER TO 2M-0008 FOR INSTALLATION DETAIL. NEW UNIT SHALL MAINTAIN ALL MANUFACTURER & NEC REQUIRED CLEARANCES. COORDINATE UNIT TAGGING WITH OWNER/BUILDING REPRESENTATIVE. COORDINATE WITH DIV. 26.
- AHU SHALL BE INSTALLED AS HIGH AS POSSIBLE. ROUTE REFRIGERANT LINES TO CORRESPONDING CONDENSING UNIT LOCATED OUTSIDE. SIZE PER MANUFACTURERS RECOMMENDATIONS. 1" CONDENSATE SHALL BE RUN TO GRADE. REFER TO 4M-0006 FOR INSTALLATION DETAIL.
- COORDINATE FINAL LOCATION OF CU WITH ARCHITECT AND OWNERS REP. ROUTE REFRIGERANT PIPING BETWEEN INDOOR AND ASSOCIATED OUTDOOR UNIT. SIZE IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS. INSULATE IN ACCORDANCE WITH MECHANICAL SPECIFICATIONS. REFER TO DETAIL 51M-0006.
- DUCT WORK SHALL BE FULL SIZE OF RTU OPENING.
- ALL OUTDOOR DUCTWORK CONVEYING CONDITIONED AIR SHALL BE WATER-PROOFED, INSULATED AND PROVIDED WITH A PROTECTIVE COVER PER SPEC SECTION 230713-2.03.
- RETURN AIR OPENING TO BE COVERED WITH HARDWARE CLOTH.
- CONTRACTOR TO RUN 14X14" EXHAUST DUCT TO STORMPROOF LOUVER WITH BIRDSCREEN SIZED AS INDICATED. COORDINATE FINAL SIZING, LOCATION, AND FINISH WITH ARCHITECT AND DIV. 26. OPENING SHALL BE LOCATED NO CLOSER THAN 15'-0" TO ANY OUTSIDE AIR INTAKES.
- PROVIDE A STORM PROOF LOUVER WITH BIRD SCREEN SIZED AS INDICATED. COORDINATE FINAL SIZING AND LOCATION WITH ARCHITECT AND ELECTRICAL. LOUVER TO BE INSTALLED UNDER CANOPY COORDINATE FINISH WITH ARCHITECT. INTERLOCK MOD WITH FAN SUCH THAT MOD IS FULLY OPEN PRIOR TO FAN ENERGIZING.
- UNIT HEATER TO BE INSTALLED 13'-0" AFF PER MANUFACTURERS INSTRUCTIONS.
- CONTRACTOR TO PROVIDE CARBON MONOXIDE DETECTOR TIED IN TO EXHAUST FAN SHOWN ON PLANS TO ENERGIZE AT 25 PPM. COORDINATE WITH ARCHITECT FOR EXACT LOCATION, STYLE, AND FINISH.
- CONTRACTOR TO INTERCONNECT THERMOSTATS. VAV TO MAINTAIN AN AVERAGE TEMPERATURE OF ALL THERMOSTATS.
- ROUTE DUCT UP THROUGH ROOF. PROVIDE WITH A GREENHECK FABRA HOOD AND BIRDSCREEN. REFER TO DETAIL 71M-0008 FOR HOOD DETAIL.
- UNIT HEATER TO BE INSTALLED PER MANUFACTURERS INSTRUCTIONS. COORDINATE MOUNTING HEIGHT WITH ARCHITECT PRIOR TO INSTALLATION.