part IV (c) - facility services subgroup

These guidelines shall both inform and supplement the Construction Documents. The Construction Documents shall address all applicable provisions included herein, by way of specification, general notes, detail, and instructions to the Contractor.

These guidelines are organized using the Master Specification Divisions, they are not, however, intended to replace the specification documents produced by the Architect/Engineer of Record. The language provided in the defined specification sections should be seen as supplemental to the language normally supplied by the Architect. In some cases, a full 3-PART "Guide Specification" may be provided, in those cases, the Design Professional shall modify and/or expand the language as appropriate to the project.

20.00.00 - RESERVED

21.00.00 - FIRE SUPPRESSION

- See the UA FRONT END DOCUMENTS (downloadable zip folder) for Owner-Provided SECTION 01 78 23 OPERATIONS AND MAINTENANCE DATA.

21 10 00 WATER-BASED FIRE SUPPRESSION SYSTEMS

(A.) General

(1) Underground sprinkler lead-in from the public mains shall be minimum six-inch (6″) diameter.

(2) Provide an allowance for a five (5) PSIG pressure drop between supply curve and demand point, including 250 GPM hose stream allowance.

(3) Provide W.P.I.V. or P.I.V. control valves at each system riser.

(4) Provide standard fire hydrant within 100' hose lay distance of fire department pumper connection (FDC), if not already existing.

(5) Route piping such that if areas separated by four-hour rated firewalls, they shall be zoned with their own flow detector.

(6) Provide "as built" sheets showing any campus water main changes, modifications, or additions to the current UA insurance company.

(7) Provide double check detector assembly at the beginning of each system involving class 1,2,3. For systems involving classes 4,5,6 specify the proper reduced pressure detector assembly.

(8) Provide standard, soldered-link, automatic sprinklers with 165°F operating temperature; except, provide sprinklers with operating temperatures as required by NFPA 13 for installation near heating equipment or lights. In unoccupied utility areas, heads shall be Grinnell Duraspeed, ½" orifice, chrome, with two-piece white enamel escutcheon plate, deflector type SSP-1. Supply sprinkler pendants that are located less than eight (8) feet above finished floor with wire guards. Paint wire guards white in all office and toilet areas; red at other locations.

(9) For each style and temperature range required, furnish an additional two fire sprinklers for every 100 installed units, but not less than six (6) units of each type.

(10) Provide red, baked enamel, steel sprinkler cabinet to store extra sprinklers and wrenches, as required by NFPA 13.

(11) Provide an 8" diameter water-operated alarm gong on the exterior of the building adjacent to the sprinkler system riser.

(12) Equip each sprinkler system riser with a vane-type flow detector, Model #VSR-D, manufactured by Potter Electric Signal of St. Louis, Missouri, or Model #20-E-12-2, manufactured by Notifier Company of Lincoln, Nebraska. Set the adjustable delayed signal at 30 seconds. Additional flow detectors shall be required if other individuals, government agencies, or companies intend to use water flow detection information.

(13) OS&Y control valves shall be equipped with tamper switches, Model #OSYS-B manufactured by Potter Electric Signal of St. Louis, Missouri, or equivalent. Post indicator valves shall be equipped with tamper switches, Model #PIVS-B manufactured by Potter Electric Signal of St. Louis, Missouri, or equal. The OS&Y control valves and post indicator valves shall be FM labeled and installed per the manufacturer's instructions.

(B.) Submittal and Shop Drawing Review.

Before installation, submit Shop Drawings of the fire protection system and receive approval from the current UA Insurance Provider and the Facilities Management Fire Marshall.

(C.) Inspections.

All fire service lines up to and including the backflow preventer shall be inspected and approved by the City of Fayetteville before the fire line is activated.

21 11 00 FACILITY FIRE-SUPPRESSION

(A.) Water Service Piping

(1) Consultant shall locate riser and main laterals on construction plans. By note, indicate flow and pressure information that the fire protection subcontractor will need to design the system.

(1) All plans shall be reviewed and approved by the Campus Fire Marshal prior to construction.

(2) Consultant shall review submittal plans in order to check for potential freeze and coordination problems such as a fire protection lateral located directly below a relief air hood.

(3) Throttle valves for testing fire pumps shall be butterfly type valves with gear operators.

(4) Specify all water valves to have tamper switches for remote monitoring through the fire alarm.

(5) Fire alarm inputs shall also include:

(6) Fire pump running.

(7) Pump not in automatic position.

(8) Power for all 3 phases monitored and remotely monitored through fire alarm.

(B.) Facility Fire Hydrants

Hydrants. Specify fire hydrants to meet A.W.W.A. Specifications equipped with hose connections meeting the national standard fire hose thread specifications. Acceptable hydrants equal to or better than mueller A-24015 or darling B-62-B.

(1) Specify hydrants with two, size 2-1/2" and one, size 4-1/2" nozzles, which turn counterclockwise to open.

(2) Hydrant Construction. Hydrants shall be of two-piece barrel construction with breakable safety flange at ground line. Hydrant to have "O" ring stuffing box with valve seat diameter of 5" or larger. Hydrant pipe connection shall be size 6" with mechanical joint ends. Equip hydrants with the National Standard operating nut. Supply hydrant nozzle-caps without retaining chains.

(3) Acceptable Manufacturers. Hydrants equal to or better than Mueller A-24015.

(4) Location. Locate hydrant within 6 feet of the curb of the nearest roadway.

(5) Nozzle Opening. Install hydrants with 4-1/2" nozzle opening facing nearest roadway with a minimum of 14" clearance between the bottom of the lowest nozzle and the surface of the surrounding landscape and a maximum of 60".

(6) Painting. Paint hydrant in standard University color scheme of white barrel and red caps and top.

(7) Hydrant Lubricant. Furnish hydrant lubricant with each hydrant.

(8) Testing. Test hydrant prior to acceptance of the University.

(9) Documentation. Manufacturer or Contractor to supply brochure or specifications booklet.

21 11 169 FIRE DEPARTMENT CONNECTIONS

21 13 00 FIRE SUPPRESSION SPRINKLER SYSTEMS

(1) Fire Sprinkler Systems: All new buildings on the campus shall be sprinkler protected with either wet, dry, or a combination of wet/dry depending on the construction of the building and whether all spaces in the building are conditioned spaces, if not then a dry sprinkler system shall be required.

(2) All sprinkler systems shall have a free-standing FDC with 5″ Storz locking connection with a 30-degree down tilt with University furnished FDC reflective sign.

(3) The system shall have a PIV (Post Indicator Valve) which is lockable with a padlock AND is tamper switch protected along with a dedicated fire hydrant within 100 feet of the FDC.

(4) The sprinkler system shall be installed per current NFPA 13 standards, and if a fire pump is included it shall be installed per NFPA current standards and all maintenance and testing shall conform to NFPA current standards, National Electrical Code, and Arkansas Fire Prevention Code.

(5) All valves that control the flow of water in any way shall have a metal sign hung by a chain to indicate what the function of the valve is. If the valve is located in a drop

ceiling a metal sign shall be placed on the ceiling grid or on the wall to indicate there is a valve there and what function the valve provides. If the valve is behind a wall a locking door shall be provided to access the valve and a metal sign shall be affixed to the wall or door indicating a valve is there and what function the valve provides.

(6) In cases where a dry sprinkler system is needed the air compressor that feeds the system shall be permanently wired into a disconnect switch box which shall be provided with signage indicating the disconnect is feeding an air compressor and the disconnect handle shall be padlocked with university furnished padlock.

(7) On all multi-story buildings floor/sectional valves shall be provided so that floors can be isolated without interrupting the entire building.

(8) Hose cabinets shall not be provided; however, standpipes shall be located so that the distance between each standpipe connection shall not exceed 200 feet, and the pressure at the highest level of the building shall have a minimum pressure of 100 psi.

(9) Automatic sprinkler system flow switches shall have inspector test valves on the discharge side of the flow switch.

(10) While Mechanical couplings are not acceptable on process piping, the UA does accept mechanical couplings (Victaulic) on fire sprinkler lines.

21 13 14 KITCHEN HOOD CHEMICAL FIRE SUPPRESSION SYSTEMS

21 20 00 FIRE EXTINGUISHING SYSTEMS

- See SECTION 10 40 00 SAFETY SPECIALTIES for portable fire extinguishers.

Large commercial kitchens and cooking areas shall be protected by Ansul K-Gard 6-liter kitchen extinguisher.

21 22 00 CLEAN AGENT FIRE EXTINGUISHING SYSTEMS

(1) Computer rooms, data rooms, and data closets shall be protected by a minimum 4 ¾# Clean Agent fire extinguisher Ansul FE05 with a rating of 5BC.

(1) System requirements include Clean-Agent fire suppression with an addressable control panel. The system shall also include outputs for future connection to the building fire alarm system. All Clean-Agent Fire Suppression Systems to be fully compliant with NFPA 2001 Standard on Clean Agent Fire Extinguishing Systems.

22.00.00 – PLUMBING

- See the UA FRONT END DOCUMENTS (downloadable zip folder) for Owner-Provided SECTION 01 78 23 OPERATIONS AND MAINTENANCE DATA.

22 05 00 COMMON WORK RESULTS FOR PLUMBING

- See 33 14 13 PUBLIC WATER UTILITY DISTRIBUTION
- See 33 30 00 SANITARY SEWAGE UTILITIES
- See 33 51 13 NATURAL GAS PIPING
- See 33 51 33 NATURAL GAS METERING

(A.) Hangers and Supports for Plumbing Piping and Equipment

Plumbing piping hangers and supports design will follow the Arkansas Plumbing Code, section 308.

(B.) Identification for Plumbing Piping and Equipment

- See Operations and Maintenance Data Integration included in the UA FRONT END DOCUMENTS

(1) Identification of potable and non-potable water will follow the Arkansas Plumbing Code, section 608.8.

(2) Identify all domestic cold water, hot water, and hot water return piping or its insulated covering, with the name of the liquid, vapor, or gas being carried. Indicate direction of flow by arrows. Specify the identification applied on the entering and leaving side of all equipment, where pipes pass through a wall, floor, or ceiling and on long runs of pipe. Identifications shall be visible from the floor, painted on in a color contrasting to the adjacent material, and composed of Helvetica medium graphic letters.

(3) Specify the equipment in mechanical rooms to be equipped with protected equipment nameplates to prevent them from becoming illegible due to paint coating.

(C.) Facility Drainage Piping Cleanouts

(1) Floor cleanouts shall have a cast iron body and frame with an adjustable scoriated nickel bronze top. Unit shall be vertically adjustable for a minimum of two inches. When using a waterproof membrane on the floor, provide clamping collars on cleanouts. Cleanouts shall consist of wye fittings and bends with brass or bronze screw plugs. Provide cleanouts in resilient tile floors and ceramic tile floors with square top covers recessed for tile insertion. Furnish nickel-bronze square frame and cover with minimum opening of 6" by 6" at each wall cleanout. In horizontal runs above grade, cleanouts shall consist of cast brass screw plug-in fitting or in caulk cast iron ferrule.

(2) Floor Drains shall have 6" diameter, adjustable, nickel-plated brass strainer, cast iron body, caulking flange for connection to cast iron pipe, screwed outlets for connection to steel pipe, and side outlet. Provide suitable clamping device and extensions if required, where installed in connection with waterproofing membrane. Submit detailed shop drawings of these drains. Do not puncture membrane other than for

drain opening. Double drainage pattern floor drains shall have integral seepage pan for embedding in floor construction, and weep holes to provide adequate drainage from pan to drainpipe.

(3) Traps for floor drains shall incorporate a method for keeping the trap full or primed, or other method to prevent sewer gases escaping into the space.

(4) Traps shall be heavy-duty type.

22 07 00 PLUMBING INSULATION

(1) Pipe insulation thickness shall be ½":

(2) Roof drainpipe insulation shall be pre-formed fiberglass with "K" value of 0.24 at 100°F mean temperature. Insulation shall have "All Service Jacket" (ASJ).

(3) Domestic water piping insulation shall be either fiberglass as specified above, or it shall be closed cell foamed polyolefin. "K" value shall be 0.26 maximum.

(4) All pipe insulation shall comply with FHC 25/50 per ASTM E84, NFPA 255 and UL 723 surface burning characteristics. Water vapor permeance shall be 0.02 perms, maximum.

22 11 00 FACILITY WATER DISTRIBUTION

(A.) Facility Water Distribution Piping

(1) Copper tubing above grade shall be type "L" hard-drawn copper tubing with wrought copper solder-joint fittings.

(2) Copper tubing below grade outside the building shall be type "K" hard-drawn copper solder-joint fittings. All copper tubing installed in concrete slabs or in earth inside the building lines should be type "K" soft drawn copper tubing with all joints made above grade.

(B.) Backflow Prevention

(1) See Recommended Backflow Preventers (issued 2011)

(C.) Domestic Water Piping

(1) Exterior domestic water pipe 4" and larger shall be class 50 ductile iron with mechanical joints. Pipe 3" and smaller shall be type K or L drawn copper with "Sil-fos" soldered joints. All pipe located in easements shall be installed in compliance with City of Fayetteville specifications.

(2) Interior domestic water piping below floor slab shall be type K soft drawn copper. Interior domestic water piping above floor slab shall be type L hard drawn copper. Flexible, bellows type, or vinyl-coated tubing not permitted.

(3) Solder shall be composition Sb5, "Sil-fos." Provide non-corrosive flux.

(4) Brazing alloy shall be silver, AWS A5.8, Classification BCuP-3, BCup-4, or BCuP-5.

(5) Domestic Water: Where possible, grade all lines to facilitate drainage. Provide drain valves at bottom of risers. Avoid all unnecessary traps in circulating lines. Connect branch lines at bottom of main serving fixtures below and pitch down so that main may drain through fixture. Connect branch lines to top of main serving only fixtures

located on floor above. To avoid the possibility of freezing, route domestic water piping under batt insulation installed directly on top of lay-in ceilings. If pipe slope has elevated the pipe to the point that maintaining the pipe below the batts is not easily accomplished, drop the pipe at nearest available fixture branch.

(6) Valves required for the control and/or isolation of any or all parts of the systems shall be furnished, installed, and located in an accessible position, or made accessible through removable panels, etc. Several function related valves shall be grouped in a battery. Each domestic hot and cold-water branch to a group of fixtures shall be valved at the take-offs from the mains whether or not shown on the drawings. Valve each domestic hot and cold-water riser and branch to a group of fixtures. Valve domestic hot and cold water at the take-off from the riser at each floor. In the event the isolation valves are inaccessible, a hinged access panel shall be installed.

(7) Use unions or flanges at connections to all equipment to facilitate dismantling, and elsewhere as required in the erection of the pipe or in the installation of valves.

(8) Install check valves and backflow preventers horizontally if possible. In no circumstance install vertically such that check flappers dangle by gravity and let water flow past until water velocity seats the flappers.

(9) Wall hydrants shall be mounted 16" above finished grade unless noted otherwise on the drawings. Hose bibbs in toilets shall be mounted same height as lavatory stopcocks.

(10) In-line domestic water circulators with motors 1/12 horsepower or smaller may be supported by piping. Mount pumps larger than1/12 horsepower on a braced wall shelf.

(11) Use 22-gauge galvanized sheet iron sleeves where pipes pass through walls or floors not on grade. In pipe chases and above ceilings, sleeves shall extend 1½" beyond each surface. Make sleeves other than in chases and above ceilings flush with the finished surface. All sleeves, except those in pipe chases and above ceilings, shall be covered with chrome plated floor, wall, or ceiling plates. The size of sleeves shall permit the subsequent insertion of pipe of the proper size. In the case of insulated lines, the diameter of the sleeves shall be at least ½" larger than the outside diameter of the insulation.

(12) Sleeves through foundation walls and slabs on grade shall be galvanized steel with a stop plate welded to sleeve and set in wall or floor. Caulk sleeves watertight with silicone sealer.

(13) Do not route domestic water piping below floor unless indicated on Drawings.

(14) Protect pipes routed inside studs by steel plates where the pipe is within 1¼" of the stud's edge. The steel plate shall be 1/16" thick and sized to fit standard studs. The plate shall be the type that electricians use to protect wiring from drywall screws and nails.

(15) Do not allow joints or fittings below floor slab. Bring pipe up to above floor in a concealed space, sweat the joints and/or fittings, and return pipe down to below floor.

(16) Assemble cast iron bell and spigot pipe and fittings with gaskets and gasket lubricant compatible with the piping. Use approved "no-hub" joints for vent piping above grade only.

(17) Do not bend hard drawn copper tubing into ells. Use proper fittings in routing pipe. Do not cut copper tubing with a hacksaw or any other means than a tubing cutter. Remove burrs and clean both inside of fittings and outside of tubing with sand cloth or emery cloth. Make sweated and brazed joints with paste flux and Sb5 solder. Wipe excess solder from joint with a cloth while it is still liquid.

(18) Provide air chambers on all supplies both hot and cold, near each stopcock, control valve, or flush valve. Chamber shall consist of a concealed 10" length of pipe with cap of the same diameter as the branch supply. Manufactured shock arrestors, at Contractor's option, may be used in lieu of air chambers.

(D.) Domestic Water Pumps

(1) Minimum domestic water pressure on the top floor of buildings shall be 45 PSIG. Install a domestic water pressure booster system as needed to provide the required pressure at the expected flow demand. In calculating head, figure water pressure drop through the backflow preventer to be 20 feet (9 PSIG).

(1) Connect to Metasys for time scheduling control.

(2) System shall have vertical bladder type tank rated for 150 PSIG service.

(3) Plumb system with schedule 40 copper pipe. Unions or flanges shall provide a single point of connection to the building's water piping.

(4) System shall have a check valve and isolation valves.

(5) Power and control panel shall be UL listed and shall have a NEMA 1 cabinet. Panel will provide single point of connection for pump system. Controls will alternate service between the two pumps. Controls will include a transformer, pump run indicator, low suction alarm, and H-O-A selector. Provide system with starters with 3-leg overload protection.

(6) System manufactured by Tiger Flow or Facilities Management approved equal.

(7) Pumps shall be anchored to a 3½" concrete housekeeping pad.

22 13 00 FACILITY SANITARY SEWERAGE

(1) All mechanical room floor drains and sumps serving building functions including elevator pits shall discharge to sanitary sewers. A separate sump pump system should be designed to handle footing drains or other rainwater disposal to the storm water system.

(8) All waste pipes downstream of a water closet shall be 4", minimum.

(9) All waste pipe, fittings, and glands shall be by one manufacturer.

(10) Polypropylene "blue plastic" acid waste pipe joints shall be fused by manufacturer approved methods rather than be joined by mechanical fittings. Mechanical fittings will be acceptable for silicon impregnated cast iron (Duriron) pipe.

(11) Waste and vent piping, both inside and outside the building, shall be service weight, hub and spigot cast iron soil pipe and fittings. Plain end (no-hub) pipe may be used to

connect branch pipes to existing waste pipes inside the building; it may also be used for vent piping at Plumbing Contractor's option. Prior to use of no-hub pipe, the Plumbing Contractor shall obtain approval from the designer and Facilities Management. PVC or other plastic pipe may be acceptable in certain circumstances with approval of Facilities Management.

(12) Piping slopes shall conform to the Arkansas Plumbing Code section 703& 704.

(13) Per Standard Plumbing Code, only route waste from pot sinks and the floor drain nearest pot sinks to the grease interceptor. Do not permit waste from any other fixtures to flow through the grease interceptor unless the local authority having jurisdiction gives specific written instructions to do so.

(14) Cleanouts shall be easily accessible. Provide a minimum of 24" clearance for rodding. In carpeted areas, use cleanout cover as a template to cut the carpet. Bond the carpet to the cleanout cover with carpet adhesive and install carpet marker in cleanout cover. Provide cleanouts at base of vertical stacks with cleanout plug located approximately 30" above floor. Extend cleanouts to wall access cover. Cleanouts shall consist of sanitary tees.

(15) Vent all floor drains.

(16) Specify all cast iron soil pipe 6″ and smaller installed above grade for drainage to be a hubless cast iron pipe as approved in the Hubless Cast Iron Soil Pipe Institute Standards 301-67T.

(17) Specify all cast iron soil pipe 8″ and larger and all sizes installed in earth used for drainage to be centrifugally cast service weight bell and spigot cast iron pipe, coated inside and outside with coal varnish, smooth inside, with outer and inner surfaces concentric, sound and free from defects.

(18) Specify all fittings for cast iron soil pipe to be coated cast iron soil pipe fittings of the same diameter as the pipe with which they are used and of equal quality and weight throughout.

22 14 00 FACILITY STORM DRAINAGE

(A.) General

(1) Above-grade storm drain piping shall be cast iron bell and spigot or no-hub. Contractor has the option to use insulation-wrapped PVC if insulation is sufficient to improve its flame spread rating to a level that is acceptable to all codes and local authorities having jurisdiction.

(2) Below-grade storm drain piping shall be PVC.

(B.) Roof Drains

(1) On flat roofs, provide one 4" roof drain per 1800 square feet. Consolidate drains as needed and size pipe to comply with 4" rainfall per hour tables.

(2) Roof drains shall be cast iron with flange, flashing ring, gravel stop, and galvanized cast iron dome. Secure dome to body in order to be vandal resistant.

22 33 00 ELECTRIC DOMESTIC WATER HEATERS

(A.) Domestic Water Heating Equipment

(1) Locations: Domestic water heating equipment including water heaters, domestic hot water return pumps, and tempering valves shall be located in a mechanical room.

(2) General: Domestic hot water systems shall use central water heating equipment with recirculation. Water heaters shall be steam-fired. Domestic hot water shall be generated and stored at a minimum temperature of 140 deg. F.

(3) On buildings with electric tanks, provide a contactor wired to Metsys so that the tank can be time scheduled for UNOCC periods as well as for demand load control.

(B.) Acceptable Manufacturers

(1) Domestic Water Heaters: Acceptable manufacturer is Marathon or approved equal.

(1) Water Heaters: Acceptable manufacturers for storage type water heaters are Armstrong or approved equal. Acceptable manufacturers for instantaneous water heaters are Aerco, P-K, and Leslie.

(2) Tempering Valves: Acceptable manufacturers of tempering valves are Holby, Leslie, and Powers.

(3) Domestic Hot Water Return Pumps: Acceptable manufacturers of domestic hot water return pumps are PACO, TACO, Grundfos, Bell & Gossett, Armstrong, Peerless, and Aurora.

(C.) Water Heating Equipment:

(1) General: Waters may be of the storage type or instantaneous type depending upon the specific application.

(2) Storage Type: Storage type water heaters shall be horizontal or vertical storage tanks with steam tube bundles. Recovery rates shall be determined in accordance with standard engineering practice based upon the number and type of fixtures and the selected storage tank volume. Storage type water heaters shall be selected to provide the design recovery rate using 2 psig saturated steam with 60 deg. F entering domestic cold water and 140 deg. F domestic hot water.

(3) Instantaneous Water Heaters: If sufficient space is not available for a storage tank, water heaters may be of the steam-fired instantaneous type without storage. Recovery rates shall be determined in accordance with standard engineering practice based upon the number and type of fixtures. Instantaneous water heaters shall be selected to provide the design recovery rate using 50 psig saturated steam with 60 deg. F entering domestic cold water and 140 deg. F domestic hot water.

(D.) Return Pumps:

Temperature maintenance in domestic hot water systems shall be provided by recirculation. Each system shall utilize two (2) pumps. Each pump shall be capable of providing the design recirculation flow rate. The design recirculation flow rate shall be calculated based upon the expected system heat loss with 110 deg. F domestic hot water supply temperature and 100 deg.

F domestic hot water return temperature. Domestic hot water return pumps shall be vertical in-line pumps with close-coupled motors.

(E.) Tempering Valves:

Tempering valves shall be used to blend 140 deg. F domestic hot water from the water heater with recirculated domestic hot water and domestic cold water to produce 110 deg. F domestic hot water for the building fixtures. Each domestic hot water system shall utilize two (2) tempering valves. Each valve shall be capable of accommodating the design domestic hot water system flow rate. Tempering valves shall be of the self-contained type.

(F.) Special Applications:

In special applications requiring domestic hot water supply temperatures in excess of 110 deg. F such as a commercial kitchen, domestic hot water system shall include separate recirculation systems for each water supply temperature (140 deg. F and 110 deg. F, for example). Recirculation piping shall be carefully designed such that higher temperature returns and lower temperature returns are each connected to the water heater in the correct location. Lower temperature returns must be connected such that the lower temperature return water and the make-up water are connected both to the water heater and cold-water inlets of the lower temperature tempering valves without first mixing with the higher temperature returns.

(G.) Sequences of Operation

(1) General: Domestic hot water system sequences of operation shall be in accordance with the standard system control diagrams included in the UAF IDIQ contract for automatic temperature controls.

(2) Water Heater: Steam control valve shall be modulated as required to maintain the domestic hot water supply temperature at the discharge of the storage tank at 140 deg. F. Steam valve control shall be overridden as required to prevent the domestic hot water supply temperature to the fixtures from exceeding 120 deg. F. This feature provides a safeguard from elevated domestic hot water supply temperatures to the building fixtures caused by a tempering valve failure.

(3) Tempering Valves: Tempering valves shall mix 140 deg. F domestic hot water from the water heater with cold water and recirculated water as required to maintain the domestic hot water supply temperature to the fixtures at 110 deg. F.

(4) Domestic Hot Water Return Pumps: Domestic hot water return pumps shall be sequenced in a lead-standby manner. Lead pump shall typically be in operation at all times. In the event of a lead pump failure, standby pump shall be automatically started and operated. Lead and standby pumps shall be automatically alternated on a regular basis to equalize wear.

(5) Domestic Hot Water Return Control Valves: Domestic hot water return control valves shall be modulated as required to maintain the domestic hot water return temperature at setpoint of 100 deg. F.

(H.) References

- Reference Appendix F for sample water heater and domestic hot water return pump schedules.
- Reference Appendix J for sample water heating equipment specifications including water heater, tempering valves, and domestic hot water return pump.
- Reference Appendix H for sample water heating system piping diagrams (standard and dual temperature systems).
- Reference Appendix I for sample water heating system details including water heater, domestic hot water return pump, tempering valve, and domestic hot water return control valve.

22 34 00 FUEL FIRED DOMESTIC WATER HEATERS

(A.) Domestic Water Heating Equipment

(1) Locations: Domestic water heating equipment including water heaters, domestic hot water return pumps, and tempering valves shall be located in a mechanical room.

(2) General: Domestic hot water systems shall use central water heating equipment with recirculation. Water heaters shall be steam-fired. Domestic hot water shall be generated and stored at a minimum temperature of 140 deg. F.

(3) Acceptable Manufacturers

(4) Water Heaters: Acceptable manufacturers for storage type water heaters are Armstrong or approved equal. If gas, acceptable manufacturers are Bradford White or Lochinvar. Acceptable manufacturers for instantaneous water heaters are Aerco, P-K, and Leslie.

(5) Tempering Valves: Acceptable manufacturers of tempering valves are Holby, Leslie, and Powers.

(6) Domestic Hot Water Return Pumps: Acceptable manufacturers of domestic hot water return pumps are PACO, TACO, Grundfos, Bell & Gossett, Armstrong, Peerless, and Aurora.

(B.) Water Heating Equipment:

(1) General: Waters may be of the storage type or instantaneous type depending upon the specific application.

(2) Storage Type: Storage type water heaters shall be horizontal or vertical storage tanks with steam tube bundles. Recovery rates shall be determined in accordance with standard engineering practice based upon the number and type of fixtures and the selected storage tank volume. Storage type water heaters shall be selected to provide the design recovery rate using 2 psig saturated steam with 60 deg. F entering domestic cold water and 140 deg. F domestic hot water.

(3) Instantaneous Water Heaters: If sufficient space is not available for a storage tank, water heaters may be of the steam-fired instantaneous type without storage. Recovery rates shall be determined in accordance with standard engineering practice based upon the number and type of fixtures. Instantaneous water heaters shall be selected

to provide the design recovery rate using 50 psig saturated steam with 60 deg. F entering domestic cold water and 140 deg. F domestic hot water.

(C.) Return Pumps:

Temperature maintenance in domestic hot water systems shall be provided by recirculation. Each system shall utilize two (2) pumps. Each pump shall be capable of providing the design recirculation flow rate. The design recirculation flow rate shall be calculated based upon the expected system heat loss with 110 deg. F domestic hot water supply temperature and 100 deg. F domestic hot water return temperature. Domestic hot water return pumps shall be vertical in-line pumps with close-coupled motors.

(D.) Tempering Valves:

Tempering valves shall be used to blend 140 deg. F domestic hot water from the water heater with recirculated domestic hot water and domestic cold water to produce 110 deg. F domestic hot water for the building fixtures. Each domestic hot water system shall utilize two (2) tempering valves. Each valve shall be capable of accommodating the design domestic hot water system flow rate. Tempering valves shall be of the self-contained type.

(E.) Domestic Hot Water Return Control Valves:

(1) Domestic hot water return balancing shall be provided by automatic control valves and temperature sensors located on each floor. Domestic hot water return control valves shall be of the 2-way type with modulating electronic actuators. Domestic hot water return control valves shall be designed for the *appropriate flow rate* and a maximum water pressure drop of 5 psig.

(2) Domestic hot water return flow rates shall be calculated based upon the piping heat loss and a 10 deg. F T.

(F.) Special Applications:

In special applications requiring domestic hot water supply temperatures in excess of 110 deg. F such as a commercial kitchen, domestic hot water system shall include separate recirculation systems for each water supply temperature (140 deg. F and 110 deg. F, for example). Recirculation piping shall be carefully designed such that higher temperature returns and lower temperature returns are each connected to the water heater in the correct location. Lower temperature returns must be connected such that the lower temperature return water and the make-up water are connected both to the water heater and cold water inlets of the lower temperature tempering valves without first mixing with the higher temperature returns.

(G.) Sequences of Operation

(1) General: Domestic hot water system sequences of operation shall be in accordance with the standard system control diagrams included in the UAF IDIQ contract for automatic temperature controls.

(2) Water Heater: Steam control valve shall be modulated as required to maintain the domestic hot water supply temperature at the discharge of the storage tank at 140

deg. F. Steam valve control shall be overridden as required to prevent the domestic hot water supply temperature to the fixtures from exceeding 120 deg. F. This feature provides a safeguard from elevated domestic hot water supply temperatures to the building fixtures caused by a tempering valve failure.

(3) Tempering Valves: Tempering valves shall mix 140 deg. F domestic hot water from the water heater with cold water and recirculated water as required to maintain the domestic hot water supply temperature to the fixtures at 110 deg. F.

(4) Domestic Hot Water Return Pumps: Domestic hot water return pumps shall be sequenced in a lead-standby manner. Lead pump shall typically be in operation at all times. In the event of a lead pump failure, standby pump shall be automatically started and operated. Lead and standby pumps shall be automatically alternated on a regular basis to equalize wear.

(5) Domestic Hot Water Return Control Valves: Domestic hot water return control valves shall be modulated as required to maintain the domestic hot water return temperature at setpoint of 100 deg. F.

(H.) References

- Reference Appendix F for sample water heater and domestic hot water return pump schedules.
- Reference Appendix J for sample water heating equipment specifications including water heater, tempering valves, and domestic hot water return pump.
- Reference Appendix H for sample water heating system piping diagrams (standard and dual temperature systems).
- Reference Appendix I for sample water heating system details including water heater, domestic hot water return pump, tempering valve, and domestic hot water return control valve.

22 35 00 DOMESTIC WATER HEAT EXCHANGERS

(A.) Water Heaters

(1) Where possible, use a shell-in-tube heat exchanger and tank to generate domestic hot water. Step tube bundle's steam pressure down to five (5) PSIG.

(2) Limit domestic water discharge temperature to 110°F in order to avoid potential liabilities from scalding. If water hotter than 110° is needed for a particular application, use point-of-use booster heaters.

(3) In the event central utility's steam is not available, use a gas-fired water heater.

(4) In the event the application is an isolated single fixture such as a lavatory, use an instantaneous, tankless, electric water heater.

(5) Design a hot water return system where domestic hot water pipe exceeds 30' in length.

(6) Gas-fired water heaters will be commercial/industrial grade with a 10-year warranty.

(7) Install water heater tanks on a concrete pad. Install horizontal tank with a pair of saddles.

22 40 00 PLUMBING FIXTURES

(A.) Lavatories

(1) Fixtures shall be American Standard, Crane, Eljer, or Facilities Management approved equal.
(2) Lavatory fixtures shall be white vitreous china.
(3) Vanity type lavatories shall be oval shaped self-rimming.
(4) Die-cast zinc alloy, plastic, or painted trim shall not be accepted.
(5) Escutcheons shall be heavy type, chrome plated, with setscrews.
(6) Support wall hung lavatories to wall with steel wall plate.
(7) Use carriers to mount elongated lavatories in rooms having stud walls.
(8) Drains will be stationary. Pop-up drains are not acceptable. Strainer and tailpiece shall have bright finish.
(9) Stops shall be lock shield, loose key, angle with copper alloy control valve bodies, stems and gland nuts.
(10) Traps shall be 1¼" by 1½", 17-gauge cast brass P-trap, adjustable with connected elbow and nipple to wall. Exposed metal trap surfaces, plugs, and connection hardware shall be chromium plated with a smooth bright finish.
(11) Faucets

(a) Water Conservation. Lavatory sinks with 1/2 gallon per minute vandal proof spray moderators. Sensor activated faucets shall be hardwired.
(b) Lavatories and sinks intended for disabled use shall have "gooseneck" faucet with paddle type handles.
(c) Provide lock-shield loose key or screwdriver pattern angle stops, or stops integral with faucet, with each compression type faucet, including sinks in wood and metal casework. Locate stops centrally above or below fixture in accessible location. Furnish keys for lock shield stops to Facilities Management.
(d) Faucets shall be cast or wrought brass, combination faucet with replaceable seat and centrally exposed spout. Provide laminar flow control device to limit faucet discharge to two (2) GPM. Control shall be integral with faucet. Use cast handles on faucets, formed or drop forged brass. Faucet, wall, and floor escutcheons shall have a smooth bright finish.
(e) Faucets manufactured by Chicago, T&S, or of the same manufacturer as the respective fixture. Traps and tailpieces manufactured by Chicago, McGuire, T&S, or of the same manufacturer as the respective fixture.

(B.) Water Closets

(1) Accessible water closets shall have an elongated bowl and 18" rim height.
(2) Water Conservation. Elongated bowl wall-mounted water closets with 1.6 gpf flushometers. What about dual flush?
(3) Water closets shall be white vitreous china and elongated bowl. Seats shall be white, solid molded plastic, elongated bowl, open frontless, without lid. Hinges and posts shall be either chromium plated copper alloy or plastic covered steel. Water closet fittings and accessories shall include bolts with ceramic nut covers.

(4) Flush Valves.

(a) Flush valve type fixtures shall have Sloan, Delany, or equal flush valves mounted 11½" above rim.

(b) Automatic flush valves shall be hardwired.

(5) Seat bumpers shall be integral part of flush valve.

(6) Fixtures shall be American Standard, Crane, Eljer, or Facilities Management approved equal. Wall-mounted toilets preferred.

(C.) Urinals

(1) Accessible urinals shall have elongated rim.

(2) Water Conservation. Wall-mounted urinals 1/8 gpf flushometers

(3) Urinals shall be white vitreous china with flushing rim, and 1¼" inlet spud. Urinals shall have integral trap. Urinals that require exposed P-traps are not accepted.

(4) Fixtures shall be American Standard, Crane, Eljer, or Facilities Management approved equal. Flush valves shall be Delany, Sloan, Zurn, or Facilities Management approved equal.

(5) Exposed mounting nuts shall be chrome-plated cap.

(D.) Carriers

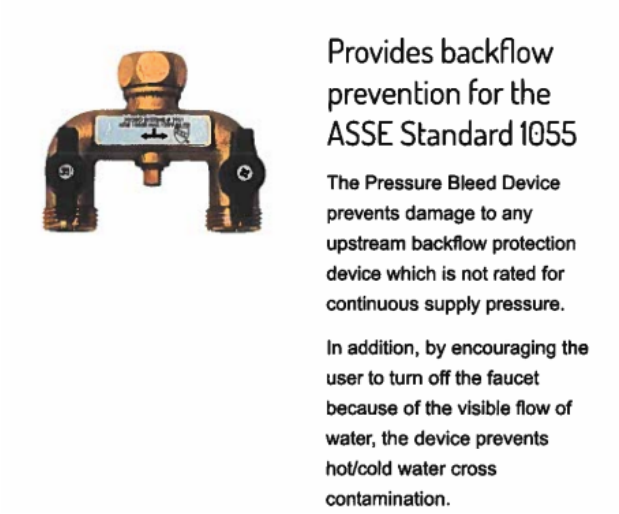
Where water closet, lavatory, or sink installation is back-to-back and carriers are specified, provide one carrier to serve both fixtures in lieu of individual carriers.

(E.) Mop Basins and Faucets

(1) Mop basin shall be floor mounted with 8" minimum curb height. Minimum dimensions shall be 24" x 24". Mop basin shall have 3" drain with strainer. Fixture may be either fiberglass or enameled cast iron at Designer's option. Enameled cast iron type fixtures shall have vinyl coated rim guard.

(1) Basin shall be American Standard, Crane, Eljer, Fiat, Williams, or Facilities Management approved equal.

(2) Faucet:
Basis of Design: T&S B-0665-BSTR-963 Wall Mount Rough Chrome Service Sink Faucet with 8" Adjustable Centers, Upper Wall Support, Built-In Stops, Eterna Cartridges, Quarter Turn Ball Valves, and Continuous Pressure Vacuum Breaker with a pressure bleed device.



(F.) Sinks and Faucets (Domestic Kitchen)

(1) Water Conservation. Kitchen sinks with 1.5 gallon per minute vandal proof laminar flow moderators.

(2) Sinks shall be 18-gauge minimum seamless stainless steel, self-rimming type with coated underside, 3½" drain opening and brushed satin finish. All sinks shall have only three faucet holes unless noted otherwise on drawings. Due to excessive maintenance, spray hose attachments are not acceptable. Due to difficulties in installing sinks in standard cabinets that have both a backsplash board and an overhanging countertop ledge, all sinks will have a front-to-back dimension of not greater than 19½".

(3) Faucets cast or wrought brass, combination faucet with replaceable seats and pivotal spout. Faucet will have smooth chrome plated finish.

(4) Stops will be loose key angle type with brass control valve bodies, stems, and gland nuts. Stop and escutcheons will have chrome plated finish.

(5) Traps will be 1½, 17-gauge cast brass P-trap. Traps, plugs, connection hardware, and escutcheons will have smooth chrome plated finish.

(6) Fixtures will be Elkay, Just, or Facilities Management approved equal.

(G.) Commercial Sinks - TBD

(H.) Emergency Showers

(1) Emergency showers shall be combination units with drench shower and eyewash. Shower shall have plastic head and stay-open, chrome-plated brass ball valve activated by a stainless-steel pull rod. Eyewash shall have plastic bowl, soft plastic heads, and chrome plated stay open brass ball valve with paddle handle. Eyewash shall be pressure compensated to provide steady flow under varying water pressure conditions. Eyewash heads shall have dust covers that automatically release when valve is actuated.

(2) Fixture manufacturer shall be Guardian, Haws, or Facilities Management approved equal.

(I.) Drinking Fountains and Water Coolers – update with "Standard"

(1) Do not substitute bottle fillers for code-required high-low drinking fountains. Bottle Fillers are supplemental to the fixture count.

(2) Fixtures will be Elkay, Halsey-Taylor, Haws, Oasis, or Facilities Management approved equal.

(3) Architect will select type of electric water cooler (surface mounted, partially recessed, etc.) for compatibility with the architecture. Water bottle filling capability should be considered in the selection of drinking fountains, especially at high student traffic areas. Please confer with Facilities Management.

(4) Stops shall be loose key angle type with brass control valve body, stem, and gland nut.

(5) Traps will be 1¼", 20-gauge cast brass P-trap with chrome plated finish.

(J.) Hose Bibbs

(1) Exterior Hose Bibbs: In all new buildings, provide exterior freeze proof hose bibbs to provide for building perimeter landscape watering. Height should be 18" off finished grade.

(2) Hose bibbs shall have an integral vacuum breaker and loose key handle. Brass casting shall have chrome finish.

22 50 00 POOL AND FOUNTAIN PLUMBING SYSTEMS

Route drains to sanitary sewer.

22 63 00 GAS SYSTEMS FOR LABORATORY AND HEALTHCARE FACILITIES

Install unions, shut off cocks, and dirt legs on natural gas piping at all gas fired appliances and equipment. Where the gas pipe is manifold to serve a group of appliances, a single dirt leg installed at the bottom of the drop to the manifold is acceptable.

22 66 00 CHEMICAL-WASTE SYSTEMS FOR LABORATORY AND HEALTHCARE FACILITIES

(A.) SINGLE-WALL PIPE

(1) Single-Wall Piping Pressure Rating: 10 feet head of water.

(1) CPVC Drainage Pipe and Fittings: ASTM D1784.

(2) Material: Special drainage systems for corrosive chemical or acid waste shall be manufactured from CPVC Type IV, ASTM Cell Classification 23447 from Spears® Manufacturing Company, or Harvel Plastics, Inc.

(3) Dimensions: All pipe shall be Schedule 40 CPVC manufactured to dimensional requirements of ASTM F441. All pipe markings shall be accompanied by a yellow stripe for identification of CPVC chemical waste system. All fittings shall be CPVC drainage patterns meeting the requirements of ASTM D3311 and specialty patterns according to the manufacturer's specifications. CPVC system shall be available in sizes 1-1/2 through 24-inch iron pipe size (IPS) dimensions.

(4) Joining Method: Joining method for pipe and fittings shall be solvent cement welding. Solvent cement shall be a "one-step" primerless type CPVC cement designated by the

system manufacturer, specially formulated for resistance to corrosive chemicals and manufactured in accordance with ASTM F493. Mechanical connections for special equipment connection or transition to other system materials shall be as specified by the CPVC system manufacturer.

(5) Flame and Smoke Conformance Rating: All molded fittings shall be CAN/ULC S102.2. Listed for flame spread and smoke development and rating designated on the original package labeling. All pipe shall be CAN/ULC S102.2 listed for flame spread and smoke development with rating designated on the pipe marking.

(6) Special Requirements and Approvals: All pipe, fittings, and cement shall be supplied together as a complete system certified by the NSF international for use in corrosive waste drainage systems as a Special Engineered (SE) Product. Installation shall be in accordance with the manufacturer's instructions and all applicable codes.

(7) PP Drainage Pipe and Fittings: ASTM F 1412, pipe extruded and drainage-pattern fittings molded, with Schedule 40 dimensions, from PP resin with fire-retardant additive complying with ASTM D 4101; with fusion and mechanical joint ends.
Exception: Pipe and fittings made from PP resin without fire-retardant additive may be used for underground installation.

(8) Manufacturers:
(a) Orion Fittings, Inc.; a division of Watts Water Technologies, Inc.

(B.) JOINING MATERIALS

(1) Couplings: Assemblies with combination of clamps, gaskets, sleeves, and threaded or flanged parts; compatible with piping and system liquid; and made by piping manufacturer for joining system piping.

(1) Adapters and Transition Fittings: Assemblies with combination of clamps, couplings, adapters, gaskets, and threaded or flanged parts; compatible with piping and system liquid; and made for joining different piping materials.

(2) Flanges: Assemblies of companion flanges and gaskets complying with ASME B16.21 and compatible with system liquid, and bolts and nuts.

(C.) Plastic Dilution Traps:

(1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

(1) Orion Fittings, Inc.; a division of Watts Water Technologies, Inc.

(2) Spears Manufacturing Company

(3) Material: Corrosion-resistant PP or CPVC with removable base.

(4) End Connections: Mechanical joint or solvent cement welding.

(5) Small Dilution Jars: 1-pint capacity, with clear base unless colored base is indicated; with NPS 1-1/2 top inlet and NPS 1-1/2 side outlet.

(6) Large Dilution Jars: 1-quart capacity; with NPS 1-1/2 top inlet and NPS 1-1/2 side outlet.

(D.) Corrosion-Resistant Traps:

(1) Type: P-trap or drum trap.

(1) Size: NPS 1-1/2 or NPS 2, as required to match connected piping.
(2) CPVC: ASTM D1784, with union connections.
(3) PP: ASTM D 4101, with mechanical-joint pipe connections.

(E.) Cast-Iron Floor Drains:

(1) See Editing Instruction No. 1 in the Evaluations for cautions about naming manufacturers. Retain first subparagraph and list of manufacturers below. See Division 01 Section "Product Requirements."
(1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:
(2) MIFAB, Inc
(3) Tyler Pipe; Wade Div.
(4) Zurn Plumbing Products Group.
(5) Standard: ASME A112.6.3.
(6) Coating: Acid resistant epoxy.
(7) Grate: Stainless steel

(F.) CPVC and PP Sink Outlets:

(1) Description: NPS 1-1/2, with clamping device.

23.00.00 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

- See the UA FRONT END DOCUMENTS (downloadable zip folder) for Owner-Provided SECTION 01 78 23 OPERATIONS AND MAINTENANCE DATA.

23 05 00 COMMON WORK RESULTS FOR HVAC (REV 11-15-2018)

(A.) HVAC Load Calculations – Outdoor Design Conditions

(1) Peak cooling air flow requirements shall be calculated using the ASHRAE 0.4% dry bulb temperature and the mean coincident wet bulb temperature.
(2) Peak cooling refrigeration (tons) and chilled water flow (GPM) requirements shall be calculated using the ASHRAE 0.4% wet bulb temperature, mean coincident dry bulb temperature, and the peak cooling air flow requirements.
(3) Peak heating requirements shall be calculated using the ASHRAE 99.6% dry bulb temperature.
(4) Peak humidification requirements shall be calculated using the ASHRAE 99.6% dry bulb temperature and the mean coincident wet bulb temperature.

(B.) HVAC Load Calculations – Indoor Design Conditions

(1) Must conform with the ESPC required temperatures.
(2) Indoor design conditions for special applications shall be discussed with Facilities Management.

Office and Administrative	Cooling – 72 deg. F and 60% RH Heating – 70 deg. F

Classrooms	Cooling – 75 deg. F and 55% RH Heating – 68 deg. F
Laboratories	Cooling – 72 deg F and 60% RH Heating – 70 deg. F and 35% RH
Corridors	Cooling – 75 deg. F and 55% RH Heating – 68 deg. F
Lobbies	Cooling – 75 deg. F and 55%RH Heating – 68 deg. F
Mechanical Rooms	Cooling – 90 deg. F Heating – 60 deg. F
Electrical Rooms	Cooling – 80 deg. F Heating – 60 deg. F
Telephone/Data Rooms	Cooling – 68 deg. F and 60% RH Heating – 68 deg. F
Computer Rooms	Cooling – 70 deg. F and 60% RH Heating – 68 deg. F and 40% RH
Public Toilet Rooms	Cooling – 75 deg. F and 55% RH Heating – 68 deg. F

(C.) Ventilation Requirement Calculations:

(1) General: Ventilation requirements shall be calculated in accordance with the requirements of ASHRAE Standard 62 latest edition[1]. Ventilation air flow calculations shall be performed using the process listed below:

(2) Breathing Zone Ventilation Requirements (Vbz): The breathing zone ventilation requirements are equal to the sum of the occupancy component and the floor area component. The occupancy component is equal to the number of people in the zone multiplied by the appropriate air flow per person[2]. The floor area component is equal to the net occupiable floor area of the space multiplied by the appropriate air flow per SF[3]. The formulas used to determine the breathing zone ventilation requirement have been designed to address contaminants generated by occupancy[4] and contaminants generated by building construction components[5].

(3) Zone Ventilation Requirements (Voz): The zone ventilation requirements are calculated by dividing the breathing zone ventilation requirements (Vbz) by the

[1] Compliance with ASHRAE Standard 62 latest edition is deemed to be compliant with the Arkansas Mechanical Code.
[2] Depends upon the type of space. Refer to the table in ASHRAE Standard 62.
[3] Also depends on the type of space. Refer to table in ASHRAE Standard 62.
[4] Primarily effluent from human respiration.
[5] Primarily volatile organic compounds off-gassed from carpet, paint, etc.

ventilation efficiency of the zone (Ez). The ventilation efficiency of the zone is a function of the type of air distribution system that is used[6].

(4) Air Handling Unit Ventilation Requirement (Vot): The air handling unit ventilation rate is calculated based upon the zone ventilation requirements. If the air handling unit is 100% outside air, the air handling unit ventilation requirement (Vot) is equal to the sum of the zone ventilation requirements. If the air handling unit uses both return air and outside air, the calculations are more complex. The first step is to determine the uncorrected air handling unit ventilation requirement (Vou). The uncorrected air handling unit ventilation requirement (Vou) is generally equal to the sum of the zone ventilation requirements. The occupancy component of the zone ventilation requirements can be adjusted to reflect occupant diversity between zones[7]. The second step is to determine the corrected air handling unit ventilation requirement (Vot). The corrected air handling unit ventilation requirement is equal to the uncorrected air handling unit ventilation requirement (Vou) divided by the system ventilation efficiency (Ev). The system ventilation efficiency (Ev) is based upon the highest zone ventilation fraction[8]. If the highest zone ventilation requirement exceeds 0.3, the HVAC Designer shall consider increasing the minimum zone supply air flow in order to reduce the zone ventilation fraction, increase the system efficiency (Ev), and reduce the air handling unit ventilation requirement (Vot).

(D.) Building Pressurization:

Ventilation requirements shall be sufficient for building pressurization. In shorter (3 stories or less), the design building pressure shall be 0.02 inches w.g. In taller buildings (more than 3 stories), the design building pressure in the summer shall be positive 0.02 inches w.g. and the design building pressure in the winter shall be negative 0.02 inches w.g.

(E.) Space Loads

(1) Cooling and heating space sensible and latent loads shall be calculated for each individual zone.

(1) Loads shall be calculated using an industry-accepted load calculation program.

(2) Space loads shall include building envelope loads, internal loads[9], and infiltration.

(F.) Air Flow Requirements

(1) Air flow requirements shall be calculated for each individual zone shall be calculated based upon the peak space sensible cooling and heating loads.

(1) Cooling air flow requirements for each zone shall typically be calculated based upon the estimated space sensible cooling load and the difference between the design

[6] Zone ventilation efficiencies vary from 0.5 up to 1.2 (underfloor air distribution systems with high returns). Refer to table in ASHRAE Standard 62.

[7] Occupant diversity between zones is common in higher education occupancies. For example, the occupants within a building may move from classroom to classroom or from a classroom to the offices.

[8] The system ventilation efficiency can either be calculated using a formula or determined from a table.

[9] Occupants, lights, equipment, etc.

cooling supply air and indoor cooling space temperatures. In unusual applications, the space latent loads may govern the cooling air flow requirements. The peak cooling air flow requirements for each air handling system shall be equal to the peak coincident sum[10] of the individual zone air flow requirements.

(2) Heating air flow requirements shall be calculated based upon the estimated space sensible heating load and the difference between the design heating supply air and indoor heating space temperatures.

(G.) Air Handling Systems

(1) The peak cooling refrigeration requirement (tons) shall be calculated for each air handling system. The peak cooling refrigeration requirement shall be calculated based upon the entering and leaving cooling coil conditions. The entering coil conditions shall be calculated assuming that exhaust air energy recovery equipment (if applicable) is not in operation. The entering coil conditions shall also consider return air heat gains. The leaving coil conditions shall be determined based upon the desired space specific humidity (apparatus dewpoint) and the fan heat gain[11].

(1) The reduction in peak cooling refrigeration requirements (tons) associated with the operation of exhaust air energy recovery equipment (if applicable) shall be calculated for each air handling system. The reduction in peak cooling refrigeration requirements shall be determined by subtracting the peak cooling refrigeration requirement with exhaust air energy recovery from the peak cooling refrigeration requirement without exhaust air energy recovery. The peak cooling refrigeration requirement with exhaust air energy recovery shall be calculated based upon the entering coil conditions assuming the exhaust air energy recovery equipment is operational and the leaving coil conditions.

(2) The peak chilled water flow requirement (GPM) shall be calculated for each air handling system based upon the estimated peak refrigeration requirement, a chilled water supply temperature of 45 deg. F, and a design chilled water T of 10 deg. F. The peak chilled water flow requirements (GPM) shall be calculated assuming exhaust air energy recovery equipment (if applicable) is not operational.

(3) The reduction in peak chilled water flow requirements (GPM) associated with the operation of exhaust air energy recovery equipment (if applicable) shall be calculated for each air handling system. The reduction in peak chilled water flow requirements shall be determined by subtracting the peak chilled water flow requirement with exhaust air energy recovery from the peak chilled water flow requirement without exhaust air energy recovery.

(4) The peak steam flow requirement shall be calculated for each air handling system. The peak steam flow requirement shall include preheat coils and humidifiers. The steam flow requirement for preheat coils shall be calculated based on the entering and leaving coil conditions. The entering coil conditions for preheat coils shall be

[10] Diversity of internal loads and solar gains shall be considered.
[11] Calculated based upon the fan static pressure, fan efficiency, motor location, and motor efficiency.

calculated based on the assumption that exhaust air energy recovery equipment (if applicable) is not in operation. The entering coil conditions for preheating coils shall also consider return air heat losses. The steam flow requirement for humidifiers shall be calculated based on the entering and leaving humidifier conditions. The entering humidifier conditions shall be calculated based on the assumption that exhaust air energy recovery equipment (if applicable) is not in operation. The leaving humidifier conditions shall consider the sensible heat gain of the humidifier (jacket steam flow).

(5) The reduction in peak steam flow requirements associated with the operation of exhaust air energy recovery equipment (if applicable) shall be calculated for each air handling system. The reduction in peak steam flow requirements shall be determined by subtracting the peak steam flow requirement with exhaust air energy recovery from the peak steam flow requirement without exhaust air energy recovery.

(6) The peak heating water flow requirement shall be calculated for each air handling unit based upon the required heat transfer rate, 100 deg F, heating water supply temperature, and 20 deg. F T.

(H.) Fan Coil Units

(1) The peak chilled water refrigeration (tons) requirement shall be determined for each fan coil unit. The peak requirement shall be equal to the capacity of the selected unit at the design conditions.

(1) The peak chilled water flow requirements (GPM) shall be calculated for each fan coil unit based upon the estimated peak refrigeration requirement, a chilled water supply temperature of 45 deg. F, and a design chilled water T of 10 deg. F.

(2) The peak heating water flow requirements (GPM) shall be calculated for each fan coil unit based upon the estimated peak heat transfer requirement, a heating water supply temperature of 180 deg. F, and a design heating water T of 30 deg. F.

(3) Air Control Device (air terminals, air valves, etc.) Reheat Coils: The peak heating water flow requirement of the air control device reheat coils shall be calculated based upon the peak heating air flow requirement, sum of the space sensible heating loads, and the design air handling system supply air temperature. The peak heating water flow requirement of the air control device reheat coils shall be calculated based upon a heating water supply temperature of 180 deg. F, and a design heating water T of 30 deg. F.

(4) Domestic Water Heating: The peak steam flow requirement for domestic water heating equipment shall be calculated based upon the estimated peak flow requirement for domestic hot water, entering cold water temperature, and the domestic hot water supply temperature. The peak steam flow requirements shall also consider heat losses from the domestic hot water supply and return piping.

(5) Chilled Water: The peak building chilled water system refrigeration (tons) and flow (GPM) requirements shall be equal to the sum of the air handling system, fan coil unit, and process equipment requirements. The reduction in the building chilled water

system peak refrigeration (tons) and flow (GPM) requirements associated with the operation of exhaust air energy recovery equipment shall also be determined.

(I.) Heating Water

(1) The peak flow (GPM) requirement for heating water shall be equal to the sum of the fan coil unit, air handling unit reheat coils, air control device reheat coils, and process equipment requirements.

(1) The peak steam requirement for the heating water converter(s) shall be calculated based upon the peak heating water flow requirement, design heating water supply temperature of 180 deg. F, and design heating water return temperature of 150 deg. F.

(2) Steam: The peak building steam flow requirement shall be equal to the sum of the air handling unit (preheat coils and humidifiers), heating water converter, and domestic water heating requirements. The reduction in building steam flow requirements associated with the operation of exhaust air energy recovery equipment shall also be determined.

(J.) HVAC System Selection (Rev 11-15-2018)

(1) HVAC systems shall be one of the following types:
- (a) Variable Air Volume
- (b) Variable Air Volume Reheat
- (c) Variable Air Volume with Underfloor Air Distribution
- (d) Single Zone
- (e) Two (2) Fan Double Duct
- (f) Fan Coil Units with Independent Ventilation System

(2) Variable air volume reheat systems offer many advantages including energy efficiency, thermal comfort, continuous dehumidification, and acceptable indoor quality. Consequently, their use is strongly encouraged. Other types of systems may be appropriate for renovations and unusual applications. Mechanical system designers shall not use other types of systems without written approval from Facility Management.

(3) Fan coil units without ventilation may be used to condition areas that are not subject to regular or continuous occupancy such as stairs, corridors, building entries, and lobbies.

(4) Fan coils units shall be used to condition mechanical rooms, use Dx ductless mini-splits in electrical rooms, and telephone/data systems. (Rev 11-15-2018)

(5) HVAC systems shall be designed to provide the correct amount of ventilation air to the occupied spaces as defined by the Arkansas Mechanical Code and ASHRAE Standard 62.

(6) HVAC systems shall be designed to limit space relative humidity to a maximum of 60%.

(7) HVAC systems shall be designed to minimize simultaneous heating and cooling.

(8) HVAC systems shall incorporate energy cost reduction strategies including weekly scheduling, unoccupied/occupied temperature and air change setpoints, supply air temperature reset, demand-controlled ventilation, static pressure reset, etc.

(9) Air-side economizer cycles shall not be used in buildings that are connected to the campus chilled water system (the campus chilled water system is equipped for hydronic free cooling). Air-side economizer cycles shall not be utilized in buildings that are equipped with humidification equipment (cost of humidification may exceed the air-side economizer savings).

(10) HVAC systems shall include provisions for exhaust air energy recovery except in applications where prohibited by code or regulation12. Exhaust air energy recovery equipment shall be capable of both sensible and latent energy recovery except in applications where prohibited by code or regulation.

(11) Other types of HVAC systems may be appropriate for unusual applications such as natatoriums, gymnasiums, warehouses, shop areas, etc. System selections for these applications shall be discussed directly with Facilities Management.

(K.) References

- Reference Appendix C for sample HVAC load calculations.

23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC

(A.) Testing, Adjusting, and Balancing of HVAC Systems

(1) General: HVAC systems shall be tested, adjusted, and balanced (TAB) in accordance with NEBB, AABC, and SMACNA standards.

(1) Examination of the Contract Documents: The TAB Contractor shall examine the Contract Documents and ensure that all devices required to complete the TAB work are indicated. The TAB Contractor shall furnish a Contract Documents Examination Report to the Engineer and the commissioning agent.

(2) Site Examination: The TAB Contractor shall not begin work prior to receiving a Notice to Proceed from the General Contractor. The TAB Contractor shall examine the completed work and ensure that the systems and equipment have been properly installed and are ready for testing, adjusting, and balancing.

(3) Air Control Devices: The TAB Contractor shall complete the following tasks: 1) verify that all control settings are correct, 2) calibrate the differential pressure transmitter, and 3) verify that the terminal damper modulates properly from minimum to maximum air flow.

(4) Air Devices: The TAB Contractor shall adjust the air flow at each air device to the design value.

(5) Air Handling Units and Energy Recovery Units: The TAB Contractor shall complete the following tasks: 1) verify proper operation of fans, dampers, and control valves, 2) calibrate air flow measuring stations, and 3) measure and record all air flows, fan speeds, and static pressures.

[12] It has been verified that the Arkansas Fire Prevention Code and the Arkansas Mechanical Code do not classify laboratory exhaust as hazardous exhaust. Consequently, exhaust air energy recovery is not prohibited for laboratory exhaust.

(6) Exhaust Fans: The TAB Contractor shall verify proper operation of motorized or backdraft dampers and measure and record air flow, static pressure, and fan speed.

(7) Chilled Water System: The TAB Contractor shall complete the following tasks: 1) verify the proper operation of building control valve, 2) calibrate the building flow meter and differential pressure transmitters, and 3) measure and record flow rates, pump speeds, and pressures.

(8) Heating Water System: The TAB Contractor shall calibrate the differential pressure transmitter and measure and record flow rates, pump speeds, and pressures.

23 06 00 SCHEDULES FOR HVAC

(A.) Air Distribution System - Acceptable Manufacturers:

(1) Weather Louvers: Acceptable manufacturers of weather louvers are Ruskin, AWV, and United Enertech.

(1) Silencers: Acceptable manufacturers of silencers are Semco or approved equal.

(2) Fire Dampers: Acceptable manufacturers of fire dampers are Ruskin, Prefco, and United Air.

(3) Smoke Dampers: Acceptable manufacturers of smoke dampers are Ruskin, Prefco, and United Air.

(4) Combination Fire and Smoke Dampers: Acceptable manufacturers of combination fire and smoke dampers are Ruskin, Prefco, and United Air.

(5) Air Devices: Acceptable manufacturers of air devices are Titus, Tuttle & Bailey, Price, and Metalaire.

(6) SMACNA Standards: Air distribution systems shall be designed and constructed in accordance with SMACNA HVAC Duct Construction Standards, latest edition.

(B.) Duct Pressure Classification:

(1) General: Mechanical system designers shall determine and specify the appropriate duct pressure class for each application. Pressure classifications shall be based upon the maximum operating duct pressure in inches w.g. The pressure class determines the minimum duct wall thickness and specifications for joints, reinforcements, and supports. Consequently, the pressure classification can significantly affect both air distribution system performance and cost.

(1) Available Pressure Classifications:

(2) Rectangular: Available pressure classes for rectangular ducts are +½″, +1″, +2″, +3″, +4″, +6″, +10″, -½″, -1″, -2″, -3″, -4″, -6″, and -10″.

(3) Round: Available pressure classes for round ducts are +2″, +4″, +10″, -2″, -4″, and -10″.

(4) Flat Oval: Available pressure classes for flat oval ducts are +1″, +3″, +4″, and +6″.

(5) Flexible Ducts: Available pressure classes for flexible ducts are +½″, +1″, +2″, +3″, +4″, +6″, +10″, -½″, and -1″.

(6) Default Pressure Classifications: If the duct pressure classification is not indicated on the Construction Documents13, the default pressure classifications are as listed below:

(7) Rectangular: +2″ for variable air volume supply ducts between air handling units and air terminals and either +1″ (positive pressure ducts) or -1″ (negative pressure ducts) for all other ducts.

(8) Round: +2″ for variable air volume supply ducts between air handling units and supply air control devices, -2″ for variable volume exhaust ducts between exhaust fans, and either +1″ (positive pressure ducts) or -1″ (negative pressure ducts) for all other ducts.

(9) Flat Oval: +2″ for variable air volume supply ducts between air handling units and supply air control devices, and +1″ for all other ducts.

(10) Flexible Ducts: +2″ for variable air volume supply ducts between air handling units and supply air control devices, and either +1″ (positive pressure ducts) or -1″ (negative pressure ducts) for all other ducts.

(11) Construction Documents: In order to prevent misunderstandings regarding duct pressure classifications, mechanical system designers shall indicate the pressure classification for all ductwork on the Construction Documents using a chart.

(C.) Duct Seal Classification:

(1) General: Mechanical system designers shall determine and specify the appropriate duct seal classification for each application. Duct seal classifications are typically based upon the maximum operating duct pressure in inches w.g. The duct seal class determines the sealing requirements. Consequently, the duct seal classification can significantly affect both air distribution system performance and cost.

(1) Available Duct Seal Classifications: Available duct seal classifications are Seal Class A, Seal Class B, and Seal Class C as described below:

(2) Seal Class A: Seal Class A provides for sealing of all transverse joints, longitudinal seams, and duct wall penetrations.

(3) Seal Class B: Seal Class B provides for sealing of transverse joints and longitudinal seams.

(4) Seal Class C: Seal Class C provides for sealing of transverse joints.

(5) Standard Duct Seal Classifications: Standard duct seal classifications are as indicated below:

(6) Seal Class A: Duct pressure classifications of +4″, +6″, +10″, -4″, -6″, and -10″.

(7) Seal Class B: Duct pressure classifications of +3″ and -3″.

(8) Seal Class C: Duct pressure classifications of 2″ and -2″. Seal Class C is also applicable to variable volume supply ducts between air handling units and supply air control devices with pressure classifications of ½″ and 1″ and variable volume exhaust ducts between exhaust fans and exhaust air control devices with pressure classifications of -½″ and -1″.

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[13] Indicating the fan external static pressure is not considered by SMACNA to be an indication of the duct pressure classification.

(9) Construction Documents: In order to prevent misunderstandings regarding duct seal classifications, mechanical system designers shall indicate the appropriate duct seal classification for all ductwork on the Construction Documents using a chart.

(10) Duct Leakage Testing: Ducts with pressure classifications of +3″, -3″, +4″, -4″, +6″, -6″, +10″, and -10″ shall be leak tested prior to its use. Leak testing shall be conducted in accordance with SMACNA HVAC Duct Leakage Test Manual.

(11) Duct leakage tests shall be witnessed by the mechanical system designer and the CxA.

(D.) Flexible Air Ducts:

(1) Acceptable Applications: Flexible air ducts may be used for final connections to supply air control devices and supply air diffusers and grilles.

(1) Maximum Lengths: Flexible air duct lengths shall not exceed 60″.

(2) Pressure Ratings: Minimum pressure ratings for flexible air ducts shall be +10″ for duct diameters from 4″ to 12″ and +6″ for duct diameters between 14″ and 16″.

(3) Insulation: Flexible duct shall be insulated. Insulation shall be fiberglass with a minimum R value of 6.0. Insulation shall be covered with a metalized polyester film (MPF) vapor barrier.

(4) UL Requirements: Flexible air ducts shall meet the requirements of UL 181.

(5) Manifold Systems: Manifold systems designed such that multiple air handling units are connected to a common air distribution system can improve HVAC system reliability. Consequently, manifold systems are preferred.

(6) Medium Pressure Supply Air Ductwork: Medium pressure supply air ductwork from air handling units or energy recovery air handling units to supply air control devices shall be round or oval spiral duct fabricated from galvanized sheet metal. Medium pressure supply air ductwork shall be fabricated, installed, and supported in accordance with SMACNA standards for the appropriate pressure class. Minimum duct pressure class shall be +3″. Medium pressure supply air ductwork shall be sealed in accordance with SMACNA standards for the appropriate duct seal class. Minimum duct seal class shall be Seal Class B. Medium pressure supply air duct sizes shall be established in accordance with standard engineering practice. Air pressure drops at the design air flows, however, shall not exceed 0.50 inches w.g. per 100 feet of duct.

(7) Low Pressure Supply Air Ductwork: Low pressure supply air ductwork from supply air control devices to the supply air diffusers shall be round or rectangular duct fabricated from galvanized sheet metal. Low pressure supply air ductwork shall be fabricated, installed, and supported in accordance with SMACNA standards for the appropriate pressure class. Minimum duct pressure class shall be +1″. Low pressure supply air duct sizes shall be established in accordance with standard engineering practice. Air pressure drops at the design air flows, however, shall not exceed 0.10 inches w.g. per 100 feet of duct.

(8) Low Pressure Return Air Ductwork: Low pressure return air ductwork from return air grilles to the air handling unit shall be round or rectangular duct fabricated from galvanized sheet metal. Low pressure return air ductwork shall be fabricated, installed,

and supported in accordance with SMACNA standards for the appropriate pressure class. Minimum duct pressure class shall be -2". Low pressure return air ductwork shall be sealed in accordance with SMACNA standards for the appropriate duct seal class. Minimum duct seal class shall be Seal Class C. Low pressure return air duct sizes shall be established in accordance with standard engineering practice. Air pressure drops at the design air flows, however, shall not exceed 0.08 inches w.g. per 100 feet of duct.

(9) Low Pressure Exhaust Air Ductwork: Low pressure exhaust air ductwork shall be round or rectangular duct fabricated from galvanized sheet metal. Low pressure return air ductwork shall be fabricated, installed, and supported in accordance with SMACNA standards for the appropriate pressure class. Minimum duct pressure class shall be -2". Low pressure exhaust air ductwork shall be sealed in accordance with SMACNA standards for the appropriate duct seal class. Minimum duct seal class shall be Seal Class C. Low pressure exhaust air duct sizes shall be established in accordance with standard engineering practice. Air pressure drops at the design air flows, however, shall not exceed 0.08 inches w.g. per 100 feet of duct.

(10) Low Pressure Outside Air Ductwork: Low pressure outside air ductwork from the outside air intakes to air handling units or energy recovery units shall be round or rectangular duct fabricated from galvanized sheet metal. Low pressure outside air ductwork shall be fabricated, installed, and supported in accordance with SMACNA standards for the appropriate pressure class. Minimum duct pressure class shall be -2". Low pressure outside air ductwork shall be sealed in accordance with SMACNA standards for the appropriate duct seal class. Minimum duct seal class shall be Seal Class C. Low pressure outside air duct sizes shall be established in accordance with standard engineering practice. Air pressure drops at the design air flows, however, shall not exceed 0.08 inches w.g. per 100 feet of duct.

(11) Medium Pressure Ventilation Air Ductwork: Medium pressure ventilation air ductwork from energy recovery units to air handling units shall be round or oval spiral duct fabricated from galvanized sheet metal. Medium pressure ductwork shall be fabricated, installed, and supported in accordance with SMACNA standards for the appropriate pressure class. Minimum duct pressure class shall be +3". Medium pressure ventilation air ductwork shall be sealed in accordance with SMACNA standards for the appropriate duct seal class. Minimum duct seal class shall be Seal Class B. Medium pressure ventilation air duct sizes shall be established in accordance with standard engineering practice. Air pressure drops at the design air flows, however, shall not exceed 0.35 inches w.g. per 100 feet of duct.

(12) Medium Pressure Exhaust Ductwork for Non-Corrosive Exhausts: Medium pressure exhaust air ductwork from energy recovery units, energy recovery air handling units, or exhaust fans to exhaust air control devices for non-corrosive exhausts shall be round spiral duct fabricated from galvanized sheet metal. Medium pressure exhaust air ductwork for non-corrosive exhausts shall be fabricated, installed, and supported in accordance with SMACNA standards for the appropriate pressure class. Minimum duct pressure class shall be -3". Medium pressure exhaust air ductwork for non-corrosive

exhausts shall be sealed in accordance with SMACNA standards for the appropriate duct seal class. Minimum duct seal class shall be Seal Class B. Medium pressure exhaust air duct sizes for non-corrosive exhausts shall be established in accordance with standard engineering practice. Air pressure drops at the design air flows, however, shall not exceed 0.35 inches w.g. per 100 feet of duct.

(13) Medium Pressure Exhaust Ductwork for Corrosive Exhausts: Medium pressure exhaust air ductwork from energy recovery units, energy recovery air handling units, or exhaust fans to exhaust air control devices for corrosive exhausts shall be round corrosion resistant PVC, round PVC coated galvanized steel duct, or round duct fabricated from Type 304 or Type 316 stainless steel with welded joints depending upon the application. Medium pressure exhaust air ductwork for corrosive exhausts shall be fabricated, installed, and supported in accordance with SMACNA standards for the appropriate pressure class. Minimum duct pressure class shall be -3". Medium pressure exhaust air ductwork for corrosive exhausts shall be sealed in accordance with SMACNA standards for the appropriate duct seal class. Minimum duct seal class shall be Seal Class B. Medium pressure exhaust air duct sizes for corrosive exhausts shall be established in accordance with standard engineering practice. Air pressure drops at the design air flows, however, shall not exceed 0.35 inches w.g. per 100 feet of duct.

(E.) Grease Hood Exhaust Ductwork:

(1) NFPA 96 Requirements: Grease hood exhaust ductwork shall be designed, fabricated, installed, and supported in accordance with NFPA 96.

(1) Duct Construction: Grease exhaust ducts shall be not less than 18-gauge stainless steel or 16-gauge carbon steel.

(2) Air Velocity: Minimum air velocity in grease hood exhaust ductwork shall be 500 FPM.

(3) Horizontal Offsets: In new construction, grease hood exhaust ducts shall be routed directly from the grease hood to a grease hood exhaust fan on the roof without any horizontal offsets or horizontal ductwork.

(4) Dishwasher Exhaust Ductwork: Dishwasher exhaust ductwork shall be fabricated from Type 304 stainless steel or aluminum with liquid tight welded joints. Dishwasher exhaust ducts shall be routed directly from the dishwasher to a dishwasher exhaust fan on the roof without any horizontal offsets or horizontal ductwork.

(5) Smoke and light test must be witnessed by the CxA.

(F.) Elevator Hoistway Ventilation:

The Arkansas Fire Prevention Code requires hoistway vents in hoistways penetrating more than 3 stories located in Group R-2 occupancies or other occupancies with overnight sleeping quarters and all other occupancies not equipped throughout with an approved sprinkler system. If hoistway vents are required, these vents shall be equipped with automatic dampers. Automatic dampers shall be opened by a programmable relay connected to the fire alarm system whenever a fire alarm initiation device located in the hoistway, elevator machine room, or elevator lobby is in alarm.

(G.) Fire Dampers:

(1) General: Fire dampers shall be installed in duct penetrations of fire resistant rated partitions, chases, and floors only where required by the Arkansas Fire Prevention Code and the Arkansas Mechanical Code. Fire dampers shall not be installed in fume hood exhaust ducts[14].

(1) Duct Access Doors: A duct access door shall be located at each fire damper.

(2) Construction Documents: The locations of fire dampers and their associated duct access doors shall be clearly indicated on the Construction Documents.

(3) Ratings: Fire damper ratings shall be 1-1/2 or 3 hour as required by the application.

(4) Fusible Links: Fusible links shall be 165 deg. F (standard) or 212 deg. F (optional) as required by the application.

(5) Sleeves, Mounting Angles, and Breakaway Connections: Fire dampers shall be furnished with sleeves, mounting angles, and breakaway connections.

(6) Style: Fire dampers shall be Style B (high free area).

(7) Pressure Class: Fire dampers shall be suitable for low, medium, and high-pressure applications.

(8) UL Requirements: Fire dampers shall meet UL requirements for primary fire dampers.

(9) Installation: Fire dampers shall be installed in strict accordance with manufacturer instructions, UL requirements, and SMACNA standards.

(H.) Smoke Dampers:

(1) General: Smoke dampers shall be installed only where required by the Arkansas Fire Prevention Code[15] and the Arkansas Mechanical Code. It should be noted that the Arkansas Fire Prevention Code and the Arkansas Mechanical Code do not require isolation smoke dampers at air handling units. It should also be noted that the Arkansas Fire Prevention Code and the Arkansas Mechanical Code do require smoke dampers at duct penetrations of chases in some applications. Mechanical system designers are encouraged to research these codes carefully.

(1) Duct Access Doors: A duct access door shall be located at each smoke damper and within arm reach.

(2) Construction Documents: The locations of smoke dampers and their associated duct access doors shall be clearly indicated on the Construction Documents.

(3) Actuators: Smoke dampers shall be equipped with pneumatic or electric actuators as required by the application.

(4) Ratings: Smoke dampers and actuators shall be qualified for up to 30 minutes exposure at 250 deg. F elevated temperature.

(5) Pressure Class: Smoke dampers shall be rated for up to 4 inches w.g. pressure and duct velocities up to 4,000 FPM.

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[14] NFPA 45 prohibits the installation of fire dampers in fume hood exhaust ducts.
[15] The Arkansas Fire Prevention Code requires smoke dampers in duct penetrations of chases in specific applications.

(6) UL Requirements: Smoke dampers shall be classified as UL555S – Leakage Rated Dampers for Use in Smoke Control Systems.

(7) Installation: Smoke dampers and actuators shall be installed in strict accordance with manufacturer instructions, UL requirements, and SMACNA standards.

(I.) Combination Fire and Smoke Dampers:

(1) General: Combination fire and smoke dampers may be installed in duct penetrations requiring both fire and smoke dampers.

(1) Duct Access Doors: A duct access door shall be located at each combination fire and smoke damper.

(2) Construction Documents: The locations of combination fire and smoke dampers shall be clearly indicated on the Construction Documents.

(3) Ratings: Combination fire and smoke damper ratings shall be 1-1/2 hour16. Smoke dampers and actuators shall be qualified for up to 30 minutes exposure at 250 deg. F elevated temperature.

(4) Fusible Links: Fusible links shall be 165 deg. F (standard) or 212 deg. F (optional) as required by the application.

(5) UL Requirements: Combination fire and smoke dampers shall meet UL requirements for primary fire dampers. Combination fire and smoke dampers shall be classified as UL555S – Leakage Rated Dampers for Use in Smoke Control Systems.

(6) Actuators: Combination fire and smoke dampers shall be equipped with pneumatic or electric actuators as required by the application.

(7) Ratings: Pressure Class: Combination fire and smoke dampers shall be rated for up to 4 inches w.g. pressure and duct velocities up to 4,000 FPM.

(8) Installation: Fire dampers shall be installed in strict accordance with manufacturer instructions, UL requirements, and SMACNA standards.

(J.) Weather Louvers:

Weather louvers shall be installed at each outside air intake. Wall mounted outside air intakes shall be a minimum of 6 feet above grade. Roof mounted outside air intakes shall be a minimum of 3 feet above the roof. Weather louvers shall be of sufficient size to prevent the penetration of snow, rain, or moisture. Weather louvers shall be equipped with bird and insect screens. A large access door[17] shall be located at each weather louver. Weather louver colors and finishes shall be coordinated with the Architect.

(K.) Duct Silencers:

(1) Duct silencers may be required to achieve the desired space noise levels. The use of duct silencers, however, is strongly discouraged. Mechanical system designers should make every effort to select "low noise" fans such that silencers are not required. If silencers are required, they should be selected and installed in strict accordance with

[16] Approved for use in fire resistant rated partitions with ratings less than 3 hours.
[17] The access door must be large enough to allow a thorough cleaning of the bird and insect screen.

manufacturer recommendations. Silencers should be selected based upon velocity, Cv, length, and insertion losses as required to minimize air pressure drop and fan energy consumption. Silencers should be designed and constructed to minimize the possibility of introducing fibrous material into the air stream. Silencers shall be installed in the same mechanical room as the air handling unit they serve.

(1) Air Devices: Supply air, exhaust air, and return air devices should be selected based upon ceiling type, air flow requirement, air pressure drop, throw, and noise levels as appropriate for the application. Air devices shall not be equipped with volume control dampers. Balancing provisions should be accomplished using manual balancing dampers located in the ducts.

(2) Control Dampers: Control dampers shall be installed in ducts where required. Control dampers should be specified in the air distribution section of the Project Specifications and shall be furnished and installed by the Sheet Metal Contractor. Actuators for control dampers should be specified in Section 17010 of the Project Specifications and furnished and installed by the Automatic Temperature Controls Contractor. A duct access door shall be installed at each control damper. The locations of control dampers shall be clearly indicated on the Construction Documents.

(3) Manual Balancing Dampers: Manual dampers shall be installed in branch ducts where required for balancing purposes. A duct access door shall be installed at each balancing damper. The locations of manual balancing dampers shall be clearly indicated on the Construction Documents.

(4) Ceiling Access Doors: Access doors shall be provided in ceilings at all fire dampers, smoke dampers, control air dampers, and manual balancing dampers located above inaccessible ceilings.

(L.) References

- Reference Appendix F for sample weather louver, silencer, and air device schedules.
- Reference Appendix J for sample air distribution specifications including fire damper, smoke damper, combination fire and smoke damper, weather louver, silencer, control damper, flexible air duct, manual balancing damper, duct access door, air device, and ceiling access doors.
- Reference Appendix I for sample air distribution system details including air device, fire damper, smoke damper, combination fire and smoke damper, weather louver, silencer, control air damper, manual balancing damper, and elevator hoistway vent.

23 07 00 HVAC INSULATION

(A.) General

(1) Piping, ductwork, and equipment shall be insulated as required to minimize heat gain and heat loss and as required to prevent condensation.

(1) Arkansas Energy Code: Insulation materials and thickness shall comply with the Arkansas Energy Code.

(2) Flame Spread and Smoke Developed Ratings: Insulating materials and coverings shall have a flame spread rating of 25 or less and a smoke developed rating of 50 or less.

(B.) Acceptable Manufacturers

(1) Flexible Elastomeric Cellular Insulation: Flexible elastomeric cellular insulation shall be as manufactured by Armstrong Armaflex or approved equal.

(1) Duct Insulation Wrap: Fiberglass duct insulation wrap shall be as manufactured by Knauf or approved equal.

(2) Duct Insulation Board: Fiberglass duct insulation board shall be manufactured by Knauf or approved equal.

(3) Fiberglass Pipe Insulation: Fiberglass pipe insulation shall be manufactured by Owens-Corning or approved equal.

(4) Vapor Retarder: Vapor retarder shall be manufactured by Childers or approved equal.

(5) Mastic Coating: Mastic coating shall be manufactured by Childers or approved equal.

(6) PVC Jackets: PVC jackets shall be manufactured by Ceel-Co or approved equal.

(C.) Ductwork in Mechanical Rooms

(1) General: Supply, return, outside air, ventilation air, and exhaust air ductwork in mechanical rooms shall be externally insulated with 1″ thick rigid fiberglass ductboard. Ductboard shall be secured with adhesive, anchor pins, and washers.

(1) Adhesive: Apply adhesive according to manufacturer's recommended coverage rate for 100% of duct surface.

(2) Anchor Pins: Anchor pin spacing shall be at 3″ from insulation end joints and 16″ on center. Cover exposed pins and washers with tape matching insulation facing.

(3) Tape: All joints and breaks in facing shall be sealed with 3″ wide, 0.02 aluminum foil scrim facing pressure sensitive tape.

(4) Hangers: Insulate duct stiffeners, hangers, and flanges that protrude beyond the insulation surface with 6″ wide strips of the same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with anchor pins spaced 6″ on center.

(5) Elbows: Apply insulation on rectangular duct elbows and transitions with a full insulation segment for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Apply insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

(6) Canvas Jacket: Insulated ductwork in mechanical rooms shall be additionally covered with 8-ounce canvas material sized with a lagging adhesive.

(D.) Concealed Ductwork

(1) General: Supply, return, outside air, ventilation air, and exhaust air ductwork where located above ceilings and chases shall be externally insulated with 2″ thick fiberglass duct wrap. Install duct wrap to obtain specified R value using maximum compression of 25%. Pull jacket tight and smooth. Install thickness in accordance with the specifications.

(1) Joints: Create a facing lap for longitudinal seams and end joint with insulation by removing 2″ from one edge and one end of insulation segment. Secure laps to adjacent insulation segment with ½″ staples located at 1″ on center. Cover staples with pressure-sensitive tape having same facing as insulation.

(2) Anchor Pins, Washers, and Mechanical Fasteners: Impale insulation over anchor pins and attach speed washers. Cover exposed pins and washers with tape matching insulation facing. On flat surfaces over 18″ wide, duct wrap shall be additionally secured to the bottom of ductwork using mechanical fasteners on 18″ centers.

(3) Tape: All joints and breaks in facing shall be sealed with 3″ wide, 0.02 aluminum foil scrim facing pressure sensitive tape. Seal all tears, punctures, and other penetrations of the duct wrap with mastic and tape to provide a vapor-tight system.

(4) Hangers: Insulate duct stiffeners, hangers, and flanges that protrude beyond the insulation surface with 6″ wide strips of the same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with anchor pins spaced 6″ on center.

(5) Elbows: Apply insulation on rectangular duct elbows and transitions with a full insulation segment for each surface. Apply insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

(6) Supply Air Grilles: The top of all supply air grilles shall be insulated with 2″ thick fiberglass duct wrap, secured in place with adhesive and thoroughly sealed. Insulation shall overlap the grille by a minimum of 2″ on all sides.

(7) Labeling: External ductwork shall be factory labeled at intervals not greater than 36″ with the name of the manufacturer, nominal thickness, density, R-value, flame spread rating, and smoke developed rating.

(8) Vapor Retarder: A low temperature vapor retarder shall be applied over all longitudinal and lateral insulation seams and joints for domestic cold water and chilled water piping. The first coat shall be a tack coat applied at a coverage rate of 2 gallons per 100 SF. While still wet, a layer of glass fiber reinforcing mesh shall be embedded with all seams overlapped a minimum of 2″. A finish coat shall be applied at a coverage rate of 2 gallons per 100 SF such that minimum film thickness is 0.038″. Insulation shall be applied with a continuous, unbroken moisture and vapor seal. All hangers, supports, anchors, or other projections secured to cold surfaces shall be insulated and vapor sealed to prevent condensation.

(9) Saddles: Galvanized steel saddles a minimum of 12″ long shall be provided at all hangers. For pipes 3″ and larger, provide pressure treated wood blocking matching insulation thickness at hangers.

(10) Mastic Coating: A mastic coating shall be applied over all longitudinal and lateral insulation seams and joints for heating water piping, domestic hot water piping, and steam piping. The mastic shall be applied in two (2) coats. A tack coat shall be applied at a rate of 2 gallons per 100 SF. While the tack coat is still wet, a layer of open weave glass fiber reinforcing mesh shall be embedded with all fabric seams overlapped a minimum of 2″. A finish coat shall be applied at a coverage rate of 2 gallons per 100

SF, covering the glass fiber reinforcing mesh such that the minimum dry film thickness is 0.063″. There shall be no voids or holidays, and the mastic shall be trowelled, sprayed, or wet brushed to a smooth even finish.

(E.) Jackets:

(1) Interior Piping: Pipe insulation in mechanical rooms and where exposed shall be protected by a PVC jacket. All ells, tees, and fitting covers shall be 2-piece, factory fabricated type. Jackets shall overlap a minimum of 2″ at longitudinal and circumferential joints. Jackets shall be secured with a welding adhesive, recommended by the jacket manufacturer. Tape shall be pressure sensitive with integral vapor barrier. PVC jackets and tape shall be color coded as follows: CHW supply = dark blue, CHW return = light blue, HHW supply = light brown, HHW return = dark brown.

(1) Exterior Piping: Pipe insulation above grade, exterior to the building, and exposed to weather shall be protected by an aluminum jacket. Jacket shall overlap not less than 2 inches at longitudinal and circumferential joints and shall be secured with bands at not more than 12-inch centers. Longitudinal joints shall be overlapped down to shed water. Circumferential joints shall be sealed with a coating recommended by the insulation manufacturer for weatherproofing seams and joints in aluminum jackets. All ell covers shall be secured with adjustable metal bands on 18-inch centers. All screws used on aluminum jackets and fittings shall be stainless steel with neoprene gaskets. The heads of screws shall be covered with GE RTV silicone. Install aluminum angle ring escutcheons at wall penetrations. Bands shall be 3/8″ wide up to 8″ diameter pipe and ¾″ wide for larger pipe.

(F.) Piping

(1) Pipe Insulation: Piping other than runouts shall be insulated with fiberglass sectional pipe insulation. Insulation shall be installed in a neat and workmanlike manner, with jackets and facing drawn tightly and smoothly cemented at all laps. All exposed ends of pipe insulation shall be pointed up neatly with insulating cement. Insulation shall be continuous through walls, ceilings, floor openings, and sleeves except where firestop or fire safing materials are required.

(1) Coil Connections: Chilled water piping shall be vapor sealed and completely insulated to the coil connection. Steam and heating water piping shall be completely insulated to the coil connection.

(2) Elbow Fittings: Elbows shall be insulated with heavy density moled factory fitting insulation or metered fitting insulation. Diaper type low density insulation will not be acceptable.

(3) Flexible Pipe Connectors: Flexible pipe connectors in chilled water piping shall be insulated to same thickness as adjoining piping. Insulating material shall be secured with copper wire ties. Insulation shall be completely covered by a continuous wrap vapor barrier material. All penetrations, facing damage, and mechanical fasteners shall be covered with a 2″ overlap to tape or mastic.

(4) Valves and Fittings: Valves and fittings shall be completely insulated with fiberglass block insulation. Vapor retarders shall overlap a minimum of 2″ at all seams and be sealed with appropriate pressure-sensitive tape or mastic. All penetrations, facing damage, and mechanical fasteners shall be covered with a 2″ overlap to tape or mastic.

(5) Pressure Gauges, Thermometers, Pressure and Temperature Test Ports, Flow Switches, Temperature Sensors, and Pressure Sensors: All cut openings or other penetrations of insulated pipes for pressure gauges, thermometers, pressure and temperature test ports, flow switches, temperature sensors, and pressure sensors shall be sealed vapor tight with sufficient layers of waterproof mastic to avoid water ponding and damage to insulation.

(6) Flanges: Flanges in chilled water piping shall be insulated. Width of insulation segment shall be the same as the overall width of the flange and bolts, plus twice the thickness of the pipe insulation. Voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments shall be filled with cut sections of sheet insulation of the same thickness as pipe insulation. Insulation shall be secured to flanges and seal seams with manufacturer's recommended adhesive. Cement all openings to insure a vapor tight seal.

(7) Devices not Insulated: Unions, flexible pipe connectors, control valves, steam pressure regulating valves, relief valves, drip pan elbows, vacuum breakers, and steam traps in heating water, domestic hot water, and steam piping shall not be insulated. Insulate piping to within 3″ of un-insulated devices.

(G.) Insulation Thickness

(1) Domestic Cold Water: ½″ thick fiberglass pipe insulation.

(2) Domestic Hot Water and Hot Water Return: 1″ thick fiberglass pipe insulation for piping 2″ and smaller, and 1-1/2″ thick fiberglass pipe insulation for piping 2-1/2″ and larger.

(3) Condensate Drain: 1″ thick fiberglass pipe insulation.

(4) Storm Drain: Insulate elbow riser, horizontal lines above ceiling, and vertical risers in chases with 1″ thick fiberglass pipe insulation.

(5) Chilled Water Supply and Return: 1″ thick fiberglass pipe insulation for piping 1-1/2″ and smaller, 1-1/2″ thick fiberglass pipe insulation for piping 2″ to 6″, and 2″ thick fiberglass pipe insulation for piping 8″ and larger.

(6) Heating Water Supply and Return: 1″ thick fiberglass pipe insulation for piping 1″ and smaller, 1-1/2″ thick fiberglass pipe insulation for piping 1-1/2″ to 4″, and 2″ thick fiberglass pipe insulation for piping 6″ and larger.

(7) Low Pressure Steam Supply and Return: 2″ thick fiberglass pipe insulation for piping 2″ and smaller, and 2-1/2″ thick fiberglass pipe insulation for piping 2-1/2″ and larger.

(8) Medium Pressure Steam Supply and Return: 2″ thick fiberglass pipe insulation for piping 1″ and smaller, 2-1/2″ thick fiberglass pipe insulation for piping 1-1/4″ to 4″, and 3″ thick fiberglass pipe insulation for piping 6″ and larger.

(9) High Pressure Steam Supply and Return: 2-1/2″ thick fiberglass pipe insulation for piping 2″ and smaller, 3″ thick fiberglass pipe insulation for piping 2-1/2″ to 4″, and 3-1/2″ thick fiberglass pipe insulation for piping 6″ and larger.

(10) Pumped Steam Return: 1-1/2″ thick fiberglass pipe insulation for piping 2″ and smaller, and 2″ thick fiberglass pipe insulation for piping 2-1/2″ and larger.

(11) Steam Relief and Steam Vent: 1″ thick fiberglass pipe insulation.

(12) Branch Piping: Insulate branch piping to chemical feeders, expansion tanks, and differential pressure transmitters, same thickness and type of insulation as adjoining piping.

(13) Runouts: Heating water runouts (5 feet maximum length) to fan coil units, air terminals, and unit heaters shall be insulated with 1″ thick flexible elastomeric cellular insulation. Chilled water runouts (5 feet maximum length) to fan coil units shall be insulated with ¾″ thick flexible elastomeric cellular insulation. Seal all seams and joints with manufacturer's recommended adhesive.

(14) Vapor Retarder: A low temperature vapor retarder shall be applied over all longitudinal and lateral insulation seams and joints for domestic cold water and chilled water piping. The first coat shall be a tack coat applied at a coverage rate of 2 gallons per 100 SF. While still wet, a layer of glass fiber reinforcing mesh shall be embedded with all seams overlapped a minimum of 2″. A finish coat shall be applied at a coverage rate of 2 gallons per 100 SF such that minimum film thickness is 0.038″. Insulation shall be applied with a continuous, unbroken moisture and vapor seal. All hangers, supports, anchors, or other projections secured to cold surfaces shall be insulated and vapor sealed to prevent condensation.

(15) Saddles: Galvanized steel saddles a minimum of 12″ long shall be provided at all hangers. For pipes 3″ and larger, provide pressure treated wood blocking matching insulation thickness at hangers.

(16) Mastic Coating: A mastic coating shall be applied over all longitudinal and lateral insulation seams and joints for heating water piping, domestic hot water piping, and steam piping. The mastic shall be applied in two (2) coats. A tack coat shall be applied at a rate of 2 gallons per 100 SF. While the tack coat is still wet, a layer of open weave glass fiber reinforcing mesh shall be embedded with all fabric seams overlapped a minimum of 2″. A finish coat shall be applied at a coverage rate of 2 gallons per 100 SF, covering the glass fiber reinforcing mesh such that the minimum dry film thickness is 0.063″. There shall be no voids or holidays, and the mastic shall be trowelled, sprayed, or wet brushed to a smooth even finish.

(H.) Jackets:

(1) Exterior Piping: Pipe insulation above grade, exterior to the building, and exposed to weather shall be protected by an aluminum jacket. Jacket shall overlap not less than 2 inches at longitudinal and circumferential joints and shall be secured with bands at not more than 12-inch centers. Longitudinal joints shall be overlapped down to shed water. Circumferential joints shall be sealed with a coating recommended by the

insulation manufacturer for weatherproofing seams and joints in aluminum jackets. All ell covers shall be secured with adjustable metal bands on 18″ centers. All screws used on aluminum jackets and fittings shall be stainless steel with neoprene gaskets. The heads of screws shall be covered with GE RTV silicone. Install aluminum angle ring escutcheons at wall penetrations. Bands shall be 3/8″ wide up to 8″ diameter pipe and ¾″ wide for larger pipe.

(1) Interior Piping: Pipe insulation in mechanical rooms and where exposed shall be protected by a PVC jacket. All ells, tees, and fitting covers shall be 2-piece, factory fabricated type. Jackets shall overlap a minimum of 2″ at longitudinal and circumferential joints. Jackets shall be secured with a welding adhesive, recommended by the jacket manufacturer. Tape shall be pressure sensitive with integral vapor barrier. PVC jackets and tape shall be color coded as follows: CHW supply = dark blue, CHW return = light blue, HHW supply = light brown, HHW return = dark brown.

(2) Labeling: All piping in mechanical rooms shall be labeled to indicate the type of fluid and the direction of flow. Labels and flow direction arrows shall be provided at intervals not greater than 20 feet.

(l.) Equipment

(1) Reheat Coils: Reheat coils serving air terminals shall be field insulated with external fiberglass duct board. Fiberglass duct board shall be sealed with mastic. The mastic shall be applied in two (2) coats. A tack coat shall be applied at a rate of 2 gallons per 100 SF. While the tack coat is still wet, a layer of open weave glass fiber reinforcing mesh shall be embedded with all fabric seams overlapped a minimum of 2″. A finish coat shall be applied at a coverage rate of 2 gallons per 100 SF, covering the glass fiber reinforcing mesh such that the minimum dry film thickness is 0.063″. There shall be no voids or holidays, and the mastic shall be trowelled, sprayed, or wet brushed to a smooth even finish.

(1) Expansion Tanks: Expansion tanks shall not be insulated.

(2) Air Separators: Air separators shall be insulated with the same material and to the same thickness as specified for the adjoining piping. Insulation shall be wired into place with 16 gauge copper wire ties. Insulation shall be covered with a PVC jacket. Insulation and jacket shall be sealed in the same manner as the piping.

(3) Chemical Feeders: Chemical feeders shall be insulated with the same material and to the same thickness as specified for the adjoining piping. Insulation shall be wired into place with 16 gauge copper wire ties. Insulation shall be covered with a PVC jacket. Insulation and jacket shall be sealed in the same manner as the piping.

(4) Chilled Water Pumps: Chilled water pumps shall not be insulated[18].

(5) Heating Water Pumps: Heating water pumps shall not be insulated.

[18] Chilled water pumps will be equipped with a drip rim base with drain piping from the base routed to a floor drain.

(6) Water Chillers: Low temperature surfaces of water chillers shall be insulated with 1″ thick flexible elastomeric cellular insulation. Seal all seams and joints with a light coat of manufacturer's recommended adhesive. Cover insulation with one layer of fiberglass fabric and 2 coats of white pigmented acrylic latex.

(7) Domestic Hot Water Storage Tanks: Domestic hot water storage tanks shall be field insulated with 2″ thick fiberglass. Insulation shall be sealed with mastic. The mastic shall be applied in two (2) coats. A tack coat shall be applied at a rate of 2 gallons per 100 SF. While the tack coat is still wet, a layer of open weave glass fiber reinforcing mesh shall be embedded with all fabric seams overlapped a minimum of 2″. A finish coat shall be applied at a coverage rate of 2 gallons per 100 SF, covering the glass fiber reinforcing mesh such that the minimum dry film thickness is 0.063″. There shall be no voids or holidays, and the mastic shall be trowelled, sprayed, or wet brushed to a smooth even finish. Mastic shall be additionally covered with a PVC jacket.

(8) Condensate Return Unit Receivers: Condensate return unit receivers shall be field insulated with 2″ thick fiberglass. Insulation shall be sealed with mastic. The mastic shall be applied in two (2) coats. A tack coat shall be applied at a rate of 2 gallons per 100 SF. While the tack coat is still wet, a layer of open weave glass fiber reinforcing mesh shall be embedded with all fabric seams overlapped a minimum of 2″. A finish coat shall be applied at a coverage rate of 2 gallons per 100 SF, covering the glass fiber reinforcing mesh such that the minimum dry film thickness is 0.063″. There shall be no voids or holidays, and the mastic shall be trowelled, sprayed, or wet brushed to a smooth even finish. Mastic shall be additionally covered with a PVC jacket.

(9) Fiberglass Pipe Insulation: Fiberglass pipe insulation shall be furnished with factory applied white all service (ASJ) vapor barrier jacket with self-sealing lap. Fittings shall be pre-molded from the same material. Fiberglass pipe insulation conductivity shall be equal to or less than 0.23 Btu-inch / hour-SF-deg. F at 75 deg. F mean temperature.

(10) Flexible Elastomeric Cellular Insulation: Flexible elastomeric cellular insulation conductivity shall be equal to or less than 0.27 Btu-inch / hour-SF-deg. F at 75 deg. F mean temperature.

(11) Fiberglass Duct Insulation Board: Fiberglass duct insulation board density shall be 3 pcf minimum. Fiberglass duct insulation board shall be furnished with a 2-mil foil scrim Kraft vapor barrier. Fiberglass duct insulation board conductivity shall be equal to or less than 0.23 Btu-inch / hour-SF-deg. F at 75 deg. F mean temperature.

(12) Fiberglass Duct Insulation Wrap: Fiberglass duct insulation wrap density shall be 0.75 pcf minimum. Fiberglass duct insulation wrap shall be furnished with 2 mil foil scrim Kraft vapor barrier jacket. Fiberglass duct insulation wrap conductivity shall be equal to or less than 0.36 Btu-inch / hour-SF- deg. F at 75 deg. F mean temperature.

(13) Vapor Retarder: Vapor retarder shall have a water vapor permeance of 0.07 perms at the mean coverage rate. Vapor retarder shall have a service temperature range of -20 deg. F to 190 deg. F.

(14) Mastic Coating: Mastic coating shall have a water vapor permeance of 1.0 perms at 0.063 inches film thickness. Mastic coating shall have a service temperature range of -40 deg. F to 180 deg. F.

(J.) Jacketing

(1) PVC Jacket: PVC jacket shall be 20 mil thick.
(1) Aluminum Jacket: Aluminum jacket shall be 0.016 inches thick.
(2) Mechanical Fasteners
(3) Weld-Attached Anchor Pins and Washers: Weld-attached anchor pins and washers shall be copper coated steel pin for capacitor-discharge welding and galvanized speed washer. Pin length shall be sufficient for the insulation thickness.
(4) Self-Adhesive Anchor Pins and Speed Washers: Self-adhesive anchor pins and speed washers shall be galvanized steel plate, pin, and washer manufactured for attachment to duct and plenum with adhesive. Pin length shall be sufficient for the insulation thickness.
(5) Staples: Staples shall be outward clinching monel or stainless steel.
(6) Wire: Wire shall be 18 gauge soft annealed galvanized, or 14-gauge copper clad steel or nickel copper alloy.
(7) Bands: Bands shall be ¾ inch nominal width, brass, galvanized steel, aluminum, or stainless steel.

(K.) Reinforcement and Finishes

(1) Glass Fabric: Glass fabric shall be open weave, ASTM D1668, Type III (resin treated) and Type I (asphalt treated).
(1) Hexagonal Wire Netting: Hexagonal wire netting shall be 1 inch mesh, 22-gauge galvanized steel.
(2) Corner Beads: Corner beads shall be 2 inch by 2 inch, 26 gauge galvanized steel or 1 inch by 1 inch, 28 gauge aluminum angle adhered to 2 inch by 2 inch Kraft paper.

(L.) Tapes

(1) Metallic Sealing Tape: Aluminum tape shall be 3 inch width with 15 mils of elastomeric modified butyl adhesive on 2 mil foil backing. Tape shall comply with UL 181B-FX and shall be equal to Hardcast "Foil Grip".
(1) Tape for Flexible Cellular Insulation: Tape for flexible cellular insulation shall be equal to Scotch No. 472 or approved equal.
(2) Glass Fiber Fitting Tape: Glass fiber fitting tape shall be Military Specification MIL-C-20079, Type II, Class I.

(M.) References

- Reference Appendix J for sample insulation specifications.
- Reference Appendix I for sample insulation details including chilled water pump, heating water pump, heating water converter, domestic water heater, and flash tank.

23 08 00 COMMISSIONING OF HVAC

- See criteria for Commissioning (Commissioning Standards 2013)

All HVAC systems will be commissioned by an independent commissioning agent (CxA) selected by Facilities Management.

(A.) HVAC Commissioning Process:

(1) The CxA shall develop the Owner's Program Requirements (OPR) for incorporation by the project designers

(1) Develop Commissioning Plan: The CxA shall develop a comprehensive commissioning plan for the project. The plan shall identify the specific pre-functional checklists and functional performance tests that will be used for the project. The CxA shall forward a copy of the commissioning plan to the Designers for review.

(2) Develop Commissioning Specifications: The CxA shall develop complete commissioning specifications for the project. The CxA shall forward the commissioning specifications to the Designers for review and inclusion in the Project Manual.

(3) Peer Review of Construction Documents: The CxA shall provide a comprehensive peer review of the completed construction documents. The CxA shall forward a list of written comments to the Design team.

(4) Review Submittals: The CxA shall review the HVAC equipment submittals and provide a written list of comments to the Design team.

(5) Action Log: The CxA shall inspect the work regularly. The CxA shall maintain a written log of issues and concerns throughout the construction process. The log shall include the item number, item description, date identified, and date resolved.

(6) Pre-Functional Checklists: The CxA shall inspect the equipment and systems and execute the pre-functional checklists.

(7) Functional Performance Tests: The CxA shall execute the functional performance tests.

(8) Review Maintenance Manuals: The CxA shall review the maintenance manuals. The CxA shall provide a list of written comments to the HVAC Designer.

(9) Commissioning Report: The CxA shall document the methodology, results, and conclusions of the commissioning process in a written commissioning report.

23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC (REV 11-15-2018)

All HVAC equipment with vendor provided controls required to interface/integrate into the Johnson Controls METASYS BMS shall be BTL (BACNet Testing Lab) certified to ensure interoperability, before approved by the University of Arkansas, Fayetteville.

(A.) Automatic Temperature Control System

- See IDIQ-ATC diagrams

(1) Acceptable Manufacturers: Automatic Temperature Control system shall be furnished and installed by the Automatic Temperature Controls provider in accordance with its IDIQ agreement.

(2) Standard System Control Diagrams: Control diagrams have been developed for standard HVAC systems. The standard systems must be used absent written approval from Facilities Management.

(B.) Design and Construction Process:

(1) Schematic Design: The HVAC Designer shall forward a copy of the completed schematic design documents to the Automatic Temperature Controls provider for review. The Automatic Temperature Controls provider shall provide a preliminary cost estimate for the ATC work including controls, VFD's, and meters.

(1) Engineering Assistance: The Automatic Temperature Controls provider shall assist the HVAC Designer with the development of automatic temperature control diagrams, sequences of operation, valve schedules, and VFD schedules for the project.

(2) 95% Construction Documents: The HVAC Designer shall prepare 95% complete construction documents for the project including control diagrams, wiring diagrams, sequences of operation, valve schedule, VFD schedule, meter schedule, and specifications. The construction documents shall include the quantity of each system.

(3) Automatic Temperature Controls provider Review: The HVAC Designer shall forward the 95% complete construction documents to the Automatic Temperature Controls provider for review. The Automatic Temperature Controls provider shall review the documents and verify their accuracy and completeness. The Automatic Temperature Controls provider shall forward a written list of comments to the HVAC Designer.

(4) 100% Construction Documents: The HVAC Designer shall revise the ATC drawings and specifications based upon the Automatic Temperature Controls provider comments.

(5) Automatic Temperature Controls provider Pricing: The Automatic Temperature Controls provider shall develop a price for the work based upon the IDIQ agreement. The Automatic Temperature Controls provider shall forward a complete pricing workbook to the HVAC Designer and Facilities Management for approval.

(6) Price Approval: After the price has been reviewed and approved by Facilities Management, the price shall be inserted into the specifications as an allowance to the General Contractor.

(7) TAB and Commissioning Assistance: In addition to furnishing and installing the automatic temperature controls, the Automatic Temperature Controls provider shall also provide TAB and Commissioning assistance.

(8) ATC IDIQ Agreement: Reference UAF IDIQ agreement for automatic temperature controls.

(9) VFD IDIQ Agreement: Reference the UAF IDIQ agreement for variable frequency drives.

(10) Standard System Control Diagrams

(11) Sample Automatic Temperature Control Specifications: Reference Appendix K for sample automatic temperature control specifications (Section 17010).

(12) Sample Variable Frequency Drive Specifications: Reference Appendix K for sample variable frequency drive specifications.

(C.) Air Control Devices:

(1) Exhaust Air Valves: Acceptable manufacturers of exhaust air valves are TSI, Phoenix, and Tek-Air.

(1) Underfloor Air Distribution Systems: Acceptable manufacturers of VAV floor diffusers and other equipment associated with underfloor air distribution systems are York and Trox.

(D.) Supply Air Control Devices:

(1) Supply Air Terminals: Acceptable manufacturers of supply air terminals are Titus, Tuttle & Bailey, Trane, and Envirotec.

(1) Number: Each office, classroom, conference room, and laboratory shall be served by a dedicated supply air control device. Serving more than one room with a single supply air control devices will not be permitted absent written approval from Facilities Management.

(2) Type: Supply air control devices shall be air terminals.

(3) Supply Air Terminals: Supply air terminals shall be equipped with averaging velocity sensors, terminal dampers, and reheat coils. Supply air terminals shall be constructed of galvanized steel. Supply air terminals shall be internally insulated. Internal insulation shall be covered with a foil scrim jacket.

(4) Supply Air Terminal Reheat Coils: Supply air terminal reheat coils shall be selected to provide a heating design air temperature of 100 deg. F with 180 deg. F heating water supply temperature, 30 deg. F T, and the design heating air flow requirement or to provide a heating design temperature equal to the design heating space temperature with 100 deg. F heating water supply temperature, 20 deg F T, and the design heating air flow requirement whichever is more stringent. Reheat coils shall be a minimum of 2 rows.

(5) Sizes: Each supply air terminal shall be selected to provide acceptable noise levels, accurate air flow measurement, and reasonable air pressure drop for the specific application. In standard applications, the minimum size air terminal shall be 6″.

(E.) Exhaust Air Control Devices:

(1) Number: In standard applications, each floor shall be served by a dedicated exhaust air control device. In laboratory applications, each laboratory and fume hood shall be served by a dedicated exhaust air control device.

(1) Type: Exhaust air control devices shall be air terminals or air valves. In standard applications, exhaust air terminals shall be used. In laboratory applications where exhaust air flows must be measured and controlled more precisely[19], exhaust air valves shall be used.

(F.) Exhaust Air Terminals:

(1) Exhaust Air Terminals: Acceptable manufacturers of exhaust air terminals are Titus, Tuttle & Bailey, Trane, and Envirotec.

(1) Exhaust air terminals shall be equipped with orifice ring flow sensors and terminal dampers. Exhaust air terminals shall be constructed of galvanized steel.

(2) Exhaust Air Valves: Exhaust air valves shall be equipped with calibrated air valves designed to provide a specific air flow at a specific valve position. Exhaust air valves serving fume hoods or other potentially corrosive exhausts shall be corrosion resistant coated or constructed of Type 316 stainless steel. Exhaust air valves serving general laboratory exhaust or other non-corrosive exhausts shall be constructed of galvanized steel or aluminum.

(3) Sizes: Each exhaust air terminal and exhaust air valve shall be selected to provide an acceptable noise level, accurate air flow measurement, and reasonable air pressure drop for the specific application.

(G.) Underfloor Air Distribution Systems

(1) General: Underfloor air distribution systems are well suited for some applications including technology classrooms, computer rooms, and office suites. Mechanical designers are encouraged to consider using underfloor air distribution systems in these applications. Underfloor air distribution systems, however, are not standard for UAF and shall not be used without prior written approval from Facilities Management.

(1) General: The design, construction, control, maintenance, and operation of underfloor air distribution systems is significantly different from conventional overhead delivery systems. The differences affect space sensible load calculations, cooling supply air temperatures, cooling air flow calculations, and ventilation requirements.

(2) Supply Air Temperature: Supply air temperatures for conventional overhead air delivery systems are typically in the range of 52 to 56 deg. F. Cooling coil discharge air temperatures are typically in the range of 48 to 52 deg. F. Supply air temperatures for underfloor air distribution systems are typically in the range of 58 to 62 deg. F[20]. To provide proper dehumidification, cooling coil discharge air temperatures must remain in the range of 48 deg. F to 52 deg. F. In most underfloor air distribution systems, the

[19] Laboratory room exhaust terminals and fume hood exhaust terminals must measure air flow precisely at reduced air flows.
[20] The higher supply air temperature is necessary to avoid occupant discomfort associated with cold floors and feet.

higher supply air temperature is achieved by allowing a portion of the return air[21] to bypass the cooling coil.

(3) Space Sensible Load Calculations: Underfloor air systems rely upon temperature stratification in the occupied zone to minimize cooling air flow requirements. As a result of the temperature stratification, a smaller portion of lighting, occupant, wall, and solar heat gains are realized as space sensible heat loads and a larger portion are realized as return air heat loads.

(4) Return Air Temperatures: As a result of the temperature stratification and the increased return air sensible loads, the return air temperatures for overhead air distribution systems are typically higher than the return air temperatures for conventional overhead air distribution systems.

(5) Cooling Supply Air Flows: As a result of the higher supply air temperature, reduced space sensible cooling load, and higher return air temperatures, cooling supply air flow requirements for underfloor air distribution systems may be significantly different than the cooling supply air flow requirements for conventional overhead air distribution systems. Since the higher return air temperature and the reduced space sensible loads work to offset the higher supply air temperature, the cooling air flow requirements may not be materially different depending upon the specifics of the application. If underfloor air distribution systems are used, mechanical system designers must calculate space sensible cooling loads, return air temperatures, and cooling supply air flows in the appropriate manner.

(6) Ventilation Rates: Studies have indicated that the zone ventilation efficiency of underfloor air distribution systems may approach 120%[22] as compared to less than 100% for conventional overhead air distribution systems. Consequently, the ventilation requirements for underfloor air distribution systems may be significantly different than the ventilation requirements for comparable conventional overhead air distribution systems.

(7) Thermostats: Each room served by the underfloor air distribution system shall be equipped with a thermostat.

(8) VAV Floor Diffusers: VAV floor diffusers shall be designed to provide a uniform air velocity throughout the entire range of air flows. VAV floor diffusers shall be equipped with electronic actuators.

(9) Recirculating Fans and Heating Water Coils: Heating is typically provided for perimeter zones in underfloor air distribution systems using recirculating fans and heating water coils.

(10) Control Air Dampers: Underfloor air distribution systems rely upon a controlled pressure in the underfloor air supply air plenums to work properly. Typically, this accomplished using modulating control air dampers located in the supply air ducts.

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[21] All ventilation air is routed through the cooling coil.

[22] A ventilation effectiveness greater than 100% can be achieved due to positive ventilation displacement. Under these circumstances, the contaminant concentrations in the occupied zone are less than the contaminant concentrations in the return duct.

To provide a uniform pressure in the underfloor plenums, the distance between the VAV floor diffusers and the control dampers must be 75 feet or less.

(H.) Sequences of Operation (Rev 11-15-2018)

General: Air control device sequences of operation shall be in accordance with the standard system control diagrams included in the UAF IDIQ contract for automatic temperature controls, see appendix.

(I.) Supply Air Terminals

(1) Mode of Operation: Mode of operation shall be occupied or unoccupied as determined by occupancy sensor, light status (current sensor), weekly schedule, or operator command.

(1) Occupied Mode: On an increase in space temperature, heating water control valve is closed and supply air terminal damper is modulated from the occupied minimum air flow to the cooling maximum air flow as required to maintain the space temperature at the occupied cooling space temperature setpoint. Occupied cooling space temperature setpoint shall be equal to the occupied space temperature setpoint plus 1 deg. F. Occupied space temperature setpoint shall be adjustable by the occupant at the thermostat from a minimum of 68 deg. F to a maximum of 75 deg. F. On a decrease in space temperature, supply air terminal damper is modulated from the occupied minimum air flow to the heating maximum air flow and heating water control valve is modulated open as required to maintain the space temperature at the occupied heating space temperature setpoint. Occupied heating space temperature setpoint shall be equal to the occupied space temperature setpoint less 1 deg. F.

(2) Unoccupied Mode: On an increase in space temperature, heating water control valve is closed and supply air terminal damper is modulated from the unoccupied minimum air flow to the cooling maximum air flow as required to maintain the space temperature at the unoccupied cooling space temperature setpoint of 85 deg. F. On a decrease in space temperature, supply air terminal damper is modulated from the unoccupied minimum air flow to the heating maximum air flow as required to maintain the space temperature at the unoccupied heating space temperature setpoint of 60 deg. F. Unoccupied minimum air flow setpoint shall be 0 CFM.

(J.) Exhaust Air Terminals

(1) Mode of Operation: Mode of operation shall be occupied or unoccupied as determined by the mode of operation for the corresponding supply air terminals, weekly schedule, or operator command. If any of the corresponding supply air terminals is in the occupied mode, the exhaust terminal shall be in the occupied mode. If none of the corresponding supply air terminals is in the occupied mode, the exhaust terminal shall be in the unoccupied mode.

(1) Occupied Mode: Exhaust terminal damper shall be modulated from the occupied minimum exhaust setpoint up to the maximum exhaust setpoint as required to prevent the building pressure from increasing above the maximum building pressure

setpoint. Maximum building pressure setpoint shall be equal to the building pressure setpoint[23] plus 0.05 inches w.g. Occupied minimum exhaust setpoints shall be determined by the occupied minimum exhaust air flows of the areas served. Occupied maximum exhaust setpoints shall established as required to provide adequate relief air flow[24] for building pressure control.

(2) Unoccupied Mode: Exhaust terminal damper shall be modulated from the unoccupied minimum exhaust setpoint up to the maximum exhaust setpoint as required to prevent the building pressure from increasing above the maximum building pressure setpoint. Maximum building pressure setpoint shall be equal to the building pressure setpoint[25] plus 0.05 inches w.g. Unoccupied minimum exhaust setpoints shall be determined by the unoccupied minimum exhaust air flows of the areas served.

(K.) Laboratory Applications

Corridor Supply Air Terminals[26]: Supply air terminal damper should be modulated from the minimum air flow setpoint up to the maximum air flow setpoint as required to maintain the building pressure at the building pressure setpoint. Heating water control valve shall be modulated as required to maintain the space temperature at setpoint of 72 deg. F.

(L.) Toilet Rooms

(1) Exhaust Air Terminals: Exhaust air terminal damper shall be modulated as required to maintain the exhaust air flow at setpoint.

(1) Supply Air Terminals: Supply air terminal damper shall be modulated as required to maintain the supply air flow at setpoint. Setpoint shall be equal to the exhaust air flow less the air flow offset[27]. Heating water control valve shall be modulated as required to maintain the space temperature at setpoint of 72 deg. F.

(M.) Office and Administrative Areas

(1) Mode of Operation: Mode of operation shall be occupied or unoccupied as determined by occupancy sensor, light status (current sensor), weekly schedule, or operator command.

(1) Occupied Mode: On an increase in space temperature, heating water control valve is closed and supply air terminal damper is modulated from the occupied minimum air flow to the cooling maximum air flow as required to maintain the space temperature at the occupied cooling space temperature setpoint. Occupied cooling space temperature setpoint shall be equal to the occupied space temperature setpoint plus 1 deg. F. Occupied space temperature setpoint shall be adjustable by the occupant at

[23] The setpoint that is controlling the AHU ventilation damper.
[24] The maximum building ventilation air flow when fully occupied may substantially exceed the total building exhaust air flow.
[25] The setpoint that is controlling the AHU ventilation damper.
[26] In laboratory buildings, corridors are typically served by supply air terminals only (no exhaust or return).
[27] Air flow offsets shall be established as required to obtain the desired space pressure relationship.

the thermostat from a minimum of 68 deg. F to a maximum of 75 deg. F. On a decrease in space temperature, supply air terminal damper is modulated from the occupied minimum air flow to the heating maximum air flow and heating water control valve is modulated open as required to maintain the space temperature at the occupied heating space temperature setpoint. Occupied heating space temperature setpoint shall be equal to the occupied space temperature setpoint less 1 deg. F. Occupied minimum air flow setpoint shall be modulated as required to maintain the space CO2 concentration at 900 ppm.

(2) Unoccupied Mode: On an increase in space temperature, heating water control valve is closed and supply air terminal damper is modulated from the unoccupied minimum air flow to the cooling maximum air flow as required to maintain the space temperature at the unoccupied cooling space temperature setpoint of 85 deg. F. On a decrease in space temperature, supply air terminal damper is modulated from the unoccupied minimum air flow to the heating maximum air flow as required to maintain the space temperature at the unoccupied heating space temperature setpoint of 60 deg. F. Unoccupied minimum air flow setpoint shall be 0 CFM.

(3) Exhaust Air Terminals[28]: Exhaust terminal damper shall be modulated as required to maintain the exhaust air flow at setpoint. Setpoint shall be equal to the sum of the supply air flows at the corresponding supply air terminals less the offset.

(N.) Laboratories

(1) Mode of Operation: Mode of operation shall be occupied or unoccupied as determined by occupancy sensor, light status (current sensor), weekly schedule, or operator command.

(1) Fume Hood Exhaust Air Valves: Fume hood exhaust air valve shall be modulated by fume hood controller as required to maintain the fume hood face velocity at setpoint. When the fume hood is in use as determined by fume hood zone presence sensor on the front of fume hood, fume hood face velocity setpoint shall be 100 FPM. When the fume hood is not in use, fume hood face velocity setpoint shall be 60 FPM.

(2) Miscellaneous Exhaust Air Valves: Air valve shall be modulated as required to maintain the exhaust air flow at setpoint.

(3) Room Exhaust Air Valve: Room exhaust air valve shall be modulated as required to maintain the total room exhaust air flow[29] at setpoint. In the occupied mode, total room exhaust air flow setpoint shall be automatically reset from a minimum of 6 air changes per hour up to a maximum of 12 air changes per hour[30] as required to maintain the space temperature at the occupied cooling space temperature setpoint. Occupied cooling space temperature setpoint shall be equal to the occupied space

[28] In laboratory applications, the HVAC system for the building may be 100% outside air. Consequently, exhaust terminals may serve office and administrative areas as well as

[29] Sum of all exhausts including miscellaneous, fume hoods, and room exhaust.

[30] The occupied maximum air change rate should be determined by the design space sensible cooling load and the supply air temperature.

temperature setpoint plus 1 deg. F. Occupied space temperature setpoint shall be adjustable by the occupant at the thermostat from a minimum of 68 deg. F to a maximum of 75 deg. F.

(4) Supply Air Terminal: Supply air terminal damper shall be modulated as required to maintain the supply air flow at the supply air flow setpoint. Setpoint shall be equal to the total exhaust air flow less the offset. On a decrease in space temperature, heating water control valve is modulated open as required to maintain the space temperature at the occupied heating space temperature setpoint. Occupied heating space temperature setpoint shall be equal to the occupied space temperature setpoint less 1 deg. F.

(5) Space Pressure Monitor: A visual indicator shall monitor the pressure relationship between the laboratory and the corridor.

(O.) Underfloor Air Distribution Systems

(1) Supply Air Control Dampers: Each supply air control damper shall be modulated as required to maintain the underfloor plenum pressure at setpoint of 0.05 inches w.g.

(2) Cooling Only Zones: Mode of operation shall be determined by occupancy sensor, light status, weekly schedule, or operator command. In the occupied mode, VAV floor diffusers are modulated from fully closed to fully open as required to maintain the space temperature at the cooling setpoint. Cooling setpoint shall be adjustable at the thermostat by the occupant from a minimum of 68 deg. F to a maximum of 75 deg. F.

(3) Mode of Operation: Mode of operation shall be determined by occupancy sensor, light status, weekly schedule, or operator command.

(4) Occupied Mode: On an increase in space temperature, recirculating fan shall be stopped, heating water control valve shall be closed, and VAV floor diffuser shall be modulated from minimum floor diffuser position setpoint to fully open as required to maintain the space temperature at the occupied cooling setpoint. Occupied cooling setpoint shall be equal to the space temperature setpoint plus 1 deg. F. Space temperature setpoint shall be adjustable at the thermostat by the occupant from a minimum of 68 deg. F to a maximum of 75 deg. F. On a decrease in space temperature, VAV floor diffusers connected to the recirculating fans shall be fully closed to the underfloor plenum and all other VAV floor diffusers shall close to the minimum floor diffuser position setpoint. On a further decrease in space temperature, the recirculating fan shall be started and the heating water control valve shall be modulated as required to maintain the space temperature at the occupied heating setpoint. Occupied heating setpoint shall be equal to the space temperature setpoint less 1 deg. F. Minimum floor diffuser position setpoint shall be automatically reset as required to maintain the CO2 concentration at 900 FPM.

(5) Unoccupied Mode: On an increase in space temperature, recirculating fan shall be stopped, heating water control valve shall be closed, and VAV floor diffuser shall be modulated from fully closed to fully open as required to maintain the space temperature at the unoccupied cooling setpoint of 85 deg. F. On a decrease in space

temperature, VAV floor diffusers connected to the recirculating fans shall be fully closed to the underfloor plenum and all other VAV floor diffusers shall be fully closed. On a further decrease in space temperature, the recirculating fan shall be started and the heating water control valve shall be modulated as required to maintain the space temperature at the unoccupied heating setpoint of 60 deg. F.

(6) Ceiling Access Doors: Access doors shall be provided in ceilings at all fire dampers, smoke dampers, control air dampers, and manual balancing dampers located above inaccessible ceilings.

(7) Sample Air Control Device Schedules: Reference Appendix F for sample supply air terminal, exhaust air terminal, exhaust air valve, and underfloor air distribution equipment schedules.

(8) Sample Air Control Device Specifications: Reference Appendix J for sample air control device specifications including supply air terminal, exhaust air terminal, exhaust air valve, and underfloor air distribution equipment.

(9) Sample Air Control Device Details: Reference Appendix I for sample air control device details including supply air terminal, exhaust air terminal, exhaust air valve, and underfloor air distribution equipment.

23 21 13 HYDRONIC PIPING (REVISED 08-28-2018)

(A.) General

(1) 2-pipe and 3-pipe systems are not acceptable. Each building shall have a chilled water pipe loop and either a steam or an independent heating water pipe system.

(2) Where practical, design reverse-return piping loops.

(3) All hydronic piping shall be schedule 40 black steel. Piping 2½" and smaller shall be threaded. Piping 3" and larger shall be welded. Schedule 10 rolled groove "Victaulic" may be used for chilled water in concealed ceiling spaces and locations other than mechanical rooms.

(4) Due to sagging problems resulting from attic heat, schedule 40 PVC may be used for fan coil unit condensate drain piping only if hangers are spaced on 48" centers. If using copper for condensate drain piping, insulate with ½" thick closed cell foam polyethylene insulation.

(5) Prohibit hydronic balance devices (circuit setters) that use factory pre-set cartridges to control flow, unless approved by Construction Coordinator. (Rev 11-15-2018)

(6) Exposed lines shall run parallel with, or perpendicular to building lines and wherever possible shall be grouped together for easy service and identification. Lines that require a definite grade for drainage take precedence in routing over all other lines. Wherever possible, hold horizontal and vertical lines close to the walls, ceiling, struts, members, etc., to occupy the minimum space consistent with the proper requirements for insulation, expansion, removal of pipe, and access to valves, dampers, etc. Concealed work shall finish-off within the limits permitted by the vertical or horizontal chases.

(7) Valves that are required for the control and/or isolation of all parts of the systems shall be furnished, installed, and located in an accessible position or made accessible through removable panels, etc. Group several valves, related as to function, in a battery. Isolation valves shall be installed for hydronic pipe take-offs from risers at each floor. In the event the isolation valves are inaccessible, a hinged access panel shall be installed. (08-28-2018)

(8) Provide swing joints, turns, expansion loops, expansion joints, or line offsets where shown on the drawings and necessary to allow for expansion. Install anchors where shown or required to control expansion of the piping system. Anchors shall be of the clamp type, securely fastened to the building structure.

(9) Use unions or flanges at connections to all equipment to facilitate dismantling, and elsewhere as required in the erection of the pipe or in the installation of valves.

(10) Use dielectric unions to connect copper coils to steel pipe and anywhere pipes of dissimilar metal are joined.

(11) Make connections to rotating equipment in such manner as to prevent transmission of vibration into the piping systems.

(12) Prohibit running thread nipples.

(13) Air separator shall be installed immediately downstream of boiler. If the particular installed boiler has an integral air separation device, air separator shall not be necessary.

(14) Mount expansion tank as high as possible. Install tank fitting and gauge glass. Install hose bibb on tank drain.

(15) Install automatic air vent at every high point of piping system, drain auto air vent to bldg drain line. (Rev 11-15-2018)

(16) Mount check valves and backflow preventers in horizontal piping whenever possible. Prohibit vertical installation in conditions where the check flapper would dangle downwards and permit backflow until water velocity seats the flapper.

(17) In the event that the shortest available thermometer stem and its compatible well is longer than the internal diameter of the pipe, a section of appropriately sized pipe shall be fitted into the piping system.

(18) The thermometer well shall be full of either glycerin or thermometer manufacturer approved heat transfer liquid.

(19) In all cases, support piping systems from structural members. Provide suitable beam clamps. In no case, drill in any building member for pipe supporting purposes. In each case, attach an extension piece of the proper size to the beam clamp. The hanging member attached to inserts or beam clamps shall be a hanger rod having machine cut threads at both ends. Select the length of the rods to meet the individual requirements.

(20) Adequately support vertical lines at their bases, either by a suitable hanger placed in the horizontal line near the riser, or by base fitting set on a pedestal or foundation and from each floor slab by means of a clamp type support bearing on the slab or beam.

(21) Hangers in contact with copper piping shall be copper plated ferrous hangers sized for copper tubing.

(22) Do not consider wire or perforated strap iron strap acceptable as a pipe hanger.

(23) Where pipes pass through walls, or floors not on grade, use 22-gauge galvanized sheet iron sleeves. In pipe chases and above ceilings, sleeves shall extend 1½" beyond each surface. Cover all sleeves, except those in pipe chases and above ceilings with chrome plated floor, wall, or ceiling plates. The size of sleeves shall readily permit the subsequent insertion of pipe of the proper size. In case of insulated lines, the diameter of the sleeves shall be at least ½" larger than the outside diameter of the insulation.

(24) Sleeves through foundation walls and slabs on grade shall be galvanized steel with a stop plate welded to sleeve and set in wall or floor. Caulk sleeves watertight with a silicone sealer.

(B.) Submittals

Specify submittals of manufacturer's literature and data for the following:

(1) Air separator
(2) Expansion tank
(3) Tank fitting
(4) Pot feeder/Chem injector
(5) Pressure regulator
(6) Pressure relief valve
(7) Automatic air vent
(8) Vacuum breaker
(9) Backflow preventer
(10) Check valve
(11) Gate Valve
(12) Plug valve
(13) Butterfly valve
(14) Union
(15) Strainer
(16) Pressure gauge
(17) Thermometer
(18) Pipe
(19) Pipe Hangers

23 21 23 END SUCTION PUMP (REV 11-15-2018)

Each hydronic system shall have a standby pump dedicated for its loop. In other words, install a standby pump for the chilled water loop and a standby pump for the heating water loop rather than have a single pump serve as standby for both services.

(20) Inlet to pump shall have either a suction diffuser or at least five pipe diameters of straight pipe between ell and inlet flange in order to assure laminar flow and prevent cavitation. In most cases, it will be simpler to install a suction diffuser.

(21) Detail pump and piping installation with all applicable trim.

(22) Pumps shall be horizontal, single stage, base mounted, end suction type.

(23) Chilled water or condensing water pumps shall be flex coupled and shall have a coupling guard. Heating water pumps shall be close coupled.

(24) Flex coupled pumps shall have ball bearings at each end of shaft housing.

(25) Impellers shall be bronze and dynamically balanced. Trim impellers at the factory to perform at the specific conditions scheduled on Drawings.

(26) Pumps with 1½" and smaller inlets shall have threaded inlets and outlets. Pump with 2" and larger inlets shall have flanged inlets and outlets.

(27) Pumps manufactured by Armstrong, Aurora, Bell & Gossett, or Facilities Management approved equal.

(28) Anchor pumps to 3½" housekeeping concrete pad. Mount pumps with five horsepower or larger motors to Mason or Facilities Management approved equivalent vibration isolators.

(29) Pumps with five horsepower or larger motor shall have braided stainless steel hose with flanged connections.

23 22 00 STEAM AND CONDENSATE PIPING AND PUMPS

(A.) Steam System

(1) Introduction: The campus system includes a single heating plant. The heating plant includes five (5) steam boilers. Each steam boiler produces 125 psig saturated steam. The boilers are manually sequenced by the operators as required to maintain the steam distribution pressure. The central campus steam system includes both 125 psig saturated steam and 40 psig saturated steam distribution sections.

(2) General: Building heating, service water heating, and humidification shall be provided a steam piping system connected to the campus steam system. A typical building steam system will include a steam isolation valve, steam meter, steam pressure regulating station, steam relief valves, flash tank, steam supply distribution piping, steam control valve(s), steam coil(s), humidifier(s), water heater(s), heating water

converter(s), steam return piping, steam traps, condensate return unit(s), and condensate meter.

(B.) Acceptable Manufacturers

(1) Gate Valves: Acceptable manufacturers of gate valves are Stockham and Nibco.
(2) Butterfly Valves: Acceptable manufacturer of steam butterfly valves is Vanessa.
(3) Check Valves: Acceptable manufacturers of check valves are Stockham and Nibco.
(4) Pressure Regulating Valves: Acceptable manufacturers of pressure regulating valves are Spence, Leslie, and Sarco.
(5) Pressure Relief Valves: Acceptable manufacturers of pressure relief valves are Kunkle, Sarco, and Leslie.
(6) Strainers: Acceptable manufacturers of strainers are Yarway, Stockham, and Nibco.
(7) Condensate Return Units: Acceptable manufacturers of condensate return units are PACO, Bell & Gossett, Aurora, and Skidmore.
(8) Flash Tanks: Acceptable manufacturers of flash tanks are Sarco and Wood Tank Products.
(9) Steam Traps: Acceptable manufacturers of steam traps are Armstrong and Sarco.

(C.) Design Temperatures and Pressures

(1) General: A typical building may utilize three (3) or more steam pressures. The standard steam pressure ranges are high, medium, and low.
(2) High Pressure Range: High pressure range is typically 100 to 125 psig. The steam from the campus system is near saturation with quality in excess of 95%.
(3) Medium Pressure Range: Medium pressure range is 40 to 60 psig. Medium pressure from the campus distribution system (as previously indicated a portion of the campus distribution system is medium pressure) varies from saturated to slightly superheated (due to the throttling process). Medium pressure steam derived from high pressure steam using a building pressure regulating station would be slightly superheated.
(4) Low Pressure Range: Low pressure range is 5 to 15 psig. Low pressure steam derived from medium pressure steam using a building pressure regulating station would be slightly superheated.
(5) Building Service Entrance: The building steam service entrance shall include isolation valve, steam flow meter, steam pressure regulating station, building isolation valve, and steam condensate meter.
(6) Steam Meters: Steam flow meters shall either be of the variable orifice (Spirax/Sarco) or vortex shedding (Rosemount) type depending upon the application. The flow meter size shall be determined based upon the peak system flow requirement in accordance with manufacturer recommendations. The flow meter shall be purchased in accordance with the UAF IDIQ steam meter contract.

(7) Steam Condensate Meters: Steam condensate flow meter shall be of the vortex shedding (Rosemount) type. The flow meter size shall be determined based upon the peak system flow requirement in accordance with manufacturer recommendations. The flow meter shall be purchased in accordance with the UAF IDIQ water meter contract.

(D.) Steam Pressure Regulating Stations

(1) General: Steam pressure regulating stations shall include steam pressure regulating valves, relief valves, strainers, isolation valves, pressure gauges, and steam traps.

(2) High Pressure to Medium Pressure to Low Pressure: Steam pressure regulating stations used to produce low pressure steam from high pressure steam shall utilize four (4) steam pressure regulating valves. Steam pressure regulating valves SPRV – 1A and SPRV – 1B shall be selected based upon an inlet pressure of 125 psig. Steam pressure regulating valve SPRV-1A shall be sized to accommodate 2/3 of the peak medium pressure steam flow requirement with an outlet pressure of 45 psig. Steam pressure regulating valve SPRV-1B shall be sized to accommodate 1/3 of the peak medium pressure steam flow requirement with an outlet pressure of 50 psig. Steam pressure regulating valves SPRV – 2A and SPRV - 2B shall be selected based upon an inlet steam pressure of 45 psig. Steam pressure regulating valve SPRV-2A shall be sized to accommodate 2/3 of the peak low pressure steam flow requirement with an outlet pressure of 5 psig. Steam pressure regulating valve SPRV-2B shall be sized to accommodate 1/3 of the peak low pressure steam flow requirement with an outlet pressure of 10 psig.

(3) Medium Pressure to Low Pressure: Steam pressure regulating stations used to produce low pressure steam from medium pressure steam shall utilize two (2) steam pressure regulating valves. Steam pressure regulating valves shall be selected based upon an inlet pressure of 40 psig (medium pressure) and an outlet pressure of 10 psig (low pressure). Steam pressure regulating valve SPRV-1A shall be sized to accommodate 2/3 of the peak low pressure steam flow requirement. Steam pressure regulating valve SPRV-1B shall be sized to accommodate 1/3 of the peak low pressure steam flow requirement.

(4) Bypass: A pipe bypass with manual globe valves shall be provided for each set of steam pressure regulating valves.

(E.) Steam System Warm-up Provisions

(1) General: Steam system start-ups shall be supervised.

(2) Drain Valves: Manual drain valves shall be provided at each drain point. Manual drain valves shall bypass the steam drip traps.

(3) Steam Drip Traps: Steam drip traps shall be sized to accommodate normal steam loads only and not warm-up loads.

(4) Isolation Valve Bypass Piping: Each large (3" or greater) steam main isolation valve shall be equipped with a 1" pipe bypass with globe valve for manual system warm-up.

(F.) Air Handling Unit Preheat Steam Coils:

(1) Type: Air handling preheat steam control valves shall be of the 2-way, modulating, normally open, globe type.

(2) Actuator: Actuators shall be modulating electronic or pneumatic depending upon the application.

(3) Sizing: Air handling unit steam preheat coil control valves shall be sized based upon a maximum pressure drop of 5 psig at the coil design steam flow rate.

(4) Valve Performance: Valve flow characteristic shall be modified equal percentage characteristic.

(5) Pressure and Temperature Ratings: Pressure and temperature ratings shall be suitable for the application.

(6) Close-off Ratings: Valve close-off ratings shall be suitable for the application.

(7) Connections: Valve connections shall be flanged, soldered, or threaded as required by the application.

(8) Construction: Valve stems shall be polished stainless steel. Valve trim shall be polished stainless steel or brass. Valve bodies shall be iron.

(G.) Steam Humidifiers

(1) Type: In general, humidifiers shall be furnished with control valves. Jacketed humidifiers shall be equipped with jacket steam control valves such that the jacket steam flow can be shut-off during humid weather. Humidifier steam control valves shall be of the 2-way, modulating, normally closed, globe type. Humidifier jacket steam control valves shall be of the 2-way, 2-position, normally closed, globe type.

(2) Actuator: Actuators shall be modulating electronic or pneumatic depending upon the application.

(3) Sizing: Humidifier steam coil control valves shall be sized based upon a maximum pressure drop of 5 psig at the humidifier design steam flow rate.

(4) Valve Performance: Valve flow characteristic shall be modified equal percentage characteristic.

(5) Pressure and Temperature Ratings: Pressure and temperature ratings shall be suitable for the application.

(6) Close-off Ratings: Valve close-off ratings shall be suitable for the application.

(7) Connections: Valve connections shall be flanged, soldered, or threaded as required by the application.

(8) Construction: Valve stems shall be polished stainless steel. Valve trim shall be polished stainless steel or brass. Valve bodies shall be iron.

(H.) Heating Water Converters

(1) Type: Heating water converter steam control valves shall be of the 2-way, modulating, normally open, globe type.

(2) Actuator: Actuators shall be modulating electronic or pneumatic depending upon the application.

(3) Sizing: Large converters (50 GPM of heating water flow and greater) shall be equipped with 2 steam control valves. One of the valves shall be sized for 1/3 of the total steam flow rate based upon a maximum pressure drop of 5 psig. The other valve shall be sized for 2/3 of the total steam flow rate based upon a maximum pressure drop of 5 psig. The small and large valves are to be modulated in sequence as required to maintain the heating water supply temperature at setpoint. A single steam control valve sized for the total steam flow rate at a pressure drop of 5 psig shall be used for smaller converters (less than 50 GPM of heating water flow).

(4) Valve Performance: Valve flow characteristic shall be modified equal percentage characteristic.

(5) Pressure and Temperature Ratings: Pressure and temperature ratings shall be suitable for the application.

(6) Close-off Ratings: Valve close-off ratings shall be suitable for the application.

(7) Connections: Valve connections shall be flanged, soldered, or threaded as required by the application.

(8) Construction: Valve stems shall be polished stainless steel. Valve trim shall be polished stainless steel or brass. Valve bodies shall be iron.

(I.) Water Heaters

(1) Type: Water heater steam control valves shall be of the 2-way, modulating, normally open, globe type.

(2) Actuator: Actuators shall be modulating electronic or pneumatic depending upon the application.

(3) Sizing: Water heater steam control valves shall be sized for the total steam flow rate based upon a maximum pressure drop of 5 psig.

(4) Valve Performance: Valve flow characteristic shall be modified equal percentage characteristic.

(5) Pressure and Temperature Ratings: Pressure and temperature ratings shall be suitable for the application.

(6) Close-off Ratings: Valve close-off ratings shall be suitable for the application.

(7) Connections: Valve connections shall be flanged, soldered, or threaded as required by the application.

(8) Construction: Valve stems shall be polished stainless steel. Valve trim shall be polished stainless steel or brass. Valve bodies shall be iron.

(J.) Steam Relief Valves

(1) Locations: Steam relief valves shall be provided downstream of all steam pressure regulating stations. If medium pressure steam is used within the building, a steam relief valve shall also be provided in the medium pressure steam header.

(2) General: Steam relief valves shall be equipped with enclosed springs and external safety levers. Valve bodies shall be cast iron with bronze Teflon trim.

(3) Settings: Medium pressure steam relief valve settings shall be 60 psig. Low pressure steam relief valve settings shall be 15 psig.

(4) Capacities: Steam relief valve capacities for power boilers shall be rated in accordance with ASME Section I (V code stamp) for 2 psig or 3% accumulation. All other steam relief valve capacities shall be rated in accordance with ASME Section VII (UV code stamp) for 3 psig or 10% accumulation. Steam relief valve capacities shall equal or exceed the steam pressure regulating valve capacities.

(5) Drip Pan Elbows: Drip pan elbows shall be located at the discharge of each steam relief valve.

(6) Steam Pressure Regulating Valves: Steam pressure regulating valves shall be of the pilot-actuated diaphragm operated type. The main valves shall be single-seated with hardened stainless steel trim. Valve bodies shall be cast iron. Pilots shall be mounted externally to the valve bodies.

(7) Strainers: Strainers shall be located upstream of all steam pressure regulating valves, steam traps, and steam control valves.

(K.) Steam Piping Design

(1) General: Steam piping systems shall be designed in accordance with standard engineering practice. Steam return and pumped steam return systems shall not be connected together at any time for any reason[31]. All steam relief and steam vent pipes shall be routed individually to the outside of the building. In general, steam piping should be pitched downward in the direction of flow[32].

(2) High Pressure Steam: High pressure steam mains shall be sized for a maximum velocity of 10,000 FPM and a maximum pressure drop of 5 psi per 100 feet of pipe. Total pressure drop in the high pressure main shall not exceed 20 psi.

(3) Medium Pressure Steam: Medium pressure steam mains and branch piping shall be sized for a maximum velocity of 10,000 FPM and a maximum pressure drop of 2 psi per

[31] The higher temperature of the steam return releases the oxygen in the colder pumped steam return, enhancing the potential for oxygen pitting and corrosion.

[32] A downward slope in the direction of flow ensures that condensate and steam flow in the same direction, reducing the potential for water hammer and increasing the effective capacity of the piping.

100 feet of pipe. Total pressure drop in the medium pressure steam supply piping shall not exceed 10 psi.

(4) Low Pressure Steam: Low pressure steam mains and branch piping shall be sized for a maximum velocity of 6,000 FPM and a maximum pressure drop of 1 psi per 100 feet of pipe. Total pressure drop in the low pressure steam supply piping shall not exceed 2 psi.

(5) High Pressure Steam Return: High pressure steam return piping shall be sized for a maximum pressure drop of 2 psi per 100 feet of pipe. Total pressure drop in the high steam return piping shall not exceed 10 psi.

(6) Medium Pressure Steam Return: Medium pressure steam return piping shall be sized for a maximum pressure drop of 1 psi per 100 feet of pipe. Total pressure drop medium pressure return piping shall not exceed 3 psi.

(7) Low Pressure Steam Return: Low pressure steam return piping shall be sized for a maximum pressure drop of ¼ psi (4 ounces) per 100 feet of pipe. Total pressure drop in the low pressure steam return piping shall not exceed 1 psi.

(8) Pumped Steam Return: Pumped steam return piping shall be designed for a maximum velocity of 10 feet per second and a maximum water pressure drop of 6 feet per 100 feet of pipe at the design condensate flow rate from the condensate return unit (including the safety factor). Total pressure drop in the pumped steam return piping shall not exceed 10 psi.

(9) Steam Relief: Steam relief piping shall be full size (relief valve outlet connection).

(10) Steam Vent: Steam vent piping shall be full size (receiver outlet connection).

(11) Steam Pipe and Pipe Fittings

(12) Gaskets: Gaskets shall be metal type equal to Flextalic.

(L.) High Pressure Steam

(1) 3″ and Larger: High pressure steam piping 3″ and larger shall be Schedule 40 black steel with standard seamless carbon steel 300 lb. welded fittings, butt welded joints, and 150 lb. carbon steel weld neck flanges.

(2) 2-1/2″ and Smaller: High pressure steam piping 2-1/2″ and smaller shall be Schedule 80 black steel with 300 lb. malleable iron threaded fittings.

(3) Medium Pressure Steam

(4) 3″ and Larger: Medium pressure steam piping 3″ and larger shall be Schedule 40 black steel with standard seamless carbon steel 150 lb. welded fittings, butt welded joints, and 150 lb. carbon steel weld neck flanges.

(5) 2-1/2″ and Smaller: Medium pressure steam piping 2-1/2″ and smaller shall be Schedule 80 black steel with 300 lb. malleable iron threaded fittings.

(M.) Low Pressure Steam

(1) 3″ and Larger: Low pressure steam piping 3″ and larger shall be Schedule 40 black steel with standard seamless carbon steel 150 lb. welded fittings, butt welded joints, and 150 lb. carbon steel weld neck flanges.

(2) 2-1/2″ and Smaller: Medium pressure steam piping 2-1/2″ and smaller shall be Schedule 80 black steel with 300 lb. malleable iron threaded fittings.

(N.) High Pressure Steam Return

(1) 3″ and Larger: High pressure steam piping 3″ and larger shall be Schedule 80 black steel with standard seamless carbon steel 300 lb. welded fittings, butt welded joints, and 300 lb. carbon steel weld neck flanges.

(2) 2-1/2″ and Smaller: High pressure steam return piping 2-1/2″ and smaller shall be Schedule 80 black steel with 300 lb. malleable iron threaded fittings.

(3) Medium Pressure Steam Return:

(4) 3″ and Larger: Medium pressure steam piping 3″ and larger shall be Schedule 80 black steel with standard seamless carbon steel 150 lb. welded fittings, butt welded joints, and 150 lb. carbon steel weld neck flanges.

(5) 2-1/2″ and Smaller: Medium pressure steam return piping 2-1/2″ and smaller shall be Schedule 80 black steel with 300 lb. malleable iron threaded fittings.

(O.) Low Pressure Steam Return:

(1) 3″ and Larger: Low pressure steam piping 3″ and larger shall be Schedule 80 black steel with standard seamless carbon steel 150 lb. welded fittings, butt welded joints, and 150 lb. carbon steel slip on or weld neck flanges.

(2) 2-1/2″ and Smaller: Low pressure steam return piping 2-1/2″ and smaller shall be Schedule 80 black steel with 300 lb. malleable iron threaded fittings.

(3) Pumped Steam Return: Pumped steam return piping shall be Schedule 80 black steel with 300 lb. malleable iron threaded fittings.

(P.) Steam Vent and Relief:

(1) 3″ and Larger: Steam vent and relief piping 3″ and larger shall be Schedule 40 black steel with standard seamless carbon steel 150 lb. welded fittings, butt welded joints, and 150 lb. carbon steel slip on or weld neck flanges.

(2) 2-1/2″ and Smaller: Low pressure steam return piping 2-1/2″ and smaller shall be Schedule 80 black steel with 300 lb. malleable iron threaded fittings.

(3) Isolation Valves: Isolation valves smaller than 8″ shall be of the gate type. Isolation valves 8″ and larger shall be of the butterfly type equipped with a gear operator. Valves shall be rated for steam service.

(4) Flash Tanks: High and medium pressure steam returns shall be routed to the condensate return unit through a flash tank. Flash tanks shall be of the horizontal type with perforated inlet tube. Flash tanks shall be sized based upon the volume of flash

steam that is anticipated. Flash tanks shall be configured for the recovery of flash steam to the low-pressure system.

(Q.) Steam Traps:

(1) Steam Drip Traps: Steam drips traps shall be provided upstream and downstream of steam pressure regulating valves, low points, bottom of steam risers, and immediately upstream of steam coils, heating water converters, steam-fired water heaters, and steam control valves. Steam drip traps shall also be provided in long horizontal steam lines at intervals not greater than 150 feet when the steam flow direction is downhill and not greater than 50 feet when the steam flow direction is uphill.

(2) Steam Traps: Steam traps shall also be provided at the discharge of all steam coils, heating water converters, and steam-fired water heaters.

(3) Schedule: All steam traps shall be scheduled. Each steam trap shall be provided with a unique designation.

(4) Collecting Legs: Collecting legs shall be provided at each steam trap. Collecting legs for drip traps shall be the same pipe diameter as the steam main. Collecting legs for air heating coils, unit heaters, radiators, heating water converters, and water heaters shall be the same pipe diameter as the equipment outlet connection. The length of the collecting legs shall be 1-1/2 pipe diameters but not less than 12".

(5) Type: Steam trap selections shall be in accordance with standard engineering practice. In general, steam drip traps shall be of the inverted bucket type and steam traps serving heating water converters, water heaters, air heating coils, unit heaters, and radiators shall be of the float and thermostatic type.

(6) Inverted Bucket Steam Traps: Inverted bucket steam traps shall be of the mechanical inverted bucket type with cast iron bodies, screwed NPT connections, and stainless-steel valve head and seat. Traps draining long runs of piping shall be equipped with an internal bi-metal air vent.

(7) Float and Thermostatic Steam Traps: Float and thermostatic traps shall be of the mechanical ball float type with cast iron bodies, NPT connections, all stainless-steel internal components, and stainless-steel balanced pressure thermostatic air vent capable of withstanding 45 deg. F of superheat and water hammer without sustaining damage. Internals of the trap shall be serviceable without disconnecting the piping.

(R.) Sizing

(1) General: Steam traps shall be selected based upon the amount of condensate being drained (condensate load), entering pressure, leaving pressure (back pressure), pressure drop, and safety factor.

(2) Selection Method: Steam traps may be selected using manufacturer capacity charts or computer selection programs.

(3) Condensate Load: The condensate load for steam drips shall be calculated by the designer based upon the anticipated heat loss of the piping being drained by the trap. The condensate load for heating water converters, water heaters, air heating cols, unit heaters, and radiators shall be equal to the peak steam flow requirement.

(4) Safety Factor: Steam trap capacities shall be equal to the condensate load multiplied by an appropriate safety factor for the application. In general, the safety factor shall be 3 for all traps serving air heating coils and unit heaters and 2 for all other traps.

(5) Entering Pressure: For steam drip traps, the entering pressure shall be equal to the steam pressure in the main being drained. For steam traps serving heating water converters, water heaters, air heating coils, unit heaters, and radiators, the entering steam pressure shall be equal to the steam pressure less the pressure drops of the control valve and the equipment.

(6) Leaving Pressure: For high and medium pressure steam traps, the leaving pressure shall be equal to the flash tank pressure (typically 10 psig) plus any vertical lift in the condensate piping between the trap discharge and the flash tank (2 feet of lift equal 1 psi). For low pressure traps, the leaving pressure shall be equal to the pressure in the condensate return unit receiver (typically 0 psig) plus any vertical lift between the trap discharge and the receiver.

(7) Pressure Drop: The pressure drop shall be equal to the difference between the entering pressure and the leaving pressure.

(8) Vacuum Breakers: Vacuum breakers shall be provided at all steam traps serving equipment with a steam control valve (applications where sub-atmospheric pressures may exist).

(9) Check Valves: Check valves shall be installed at all steam traps. If condensate is being lifted, check valves shall be installed at the trap outlet. If condensate is not being lifted, check valves shall be installed at the trap inlet.

(10) Isolation Valves: Isolation valves shall be installed on both sides of steam traps.

(11) Unions: Unions shall be installed on both sides of steam traps.

(12) Strainers: Pipeline strainers shall be installed ahead of all steam traps.

(13) Trap Bypass: A trap bypass with globe valve shall be provided at steam traps draining large runs of piping (for supervised manual system warm-up).

(S.) Steam Trap Monitoring System

(1) General: All buildings served by the campus steam distribution system shall be equipped with a steam trap monitoring system. Monitoring system shall include sensor chambers located at each steam trap, sensors, cables, and steam trap monitor.

(2) Sensor Chambers: Sensor chambers shall be installed in-line and upstream from all steam traps. Sensor chambers shall have steel bodies with screwed connections.

(3) Sensors: Sensors shall be screwed into each sensor chamber. Sensors shall be of stainless-steel construction with suitable insulator. Sensors shall be capable of

determining different conductivities associated with steam and condensate. The sensor shall also detect temperature drops associated with steam traps that fail closed, are blocked, or not in use.

(4) Cabling: Cabling between sensors and steam trap monitor shall be 20 gauge minimum. Cabling shall be installed in EMT conduit.

(5) Steam Trap Monitor: Steam trap monitor shall continuously scan all steam traps and verify proper operation (no waste or water logging). Monitor shall be equipped with green and red pilot light. If all traps are working properly, the green light shall be activated. If any trap is not working properly, the green light will be off and the red light for that specific trap will be activated. Monitor will be connected to the building energy management system (voltage free contact closure) for remote alarm monitoring purposes:

(T.) Condensate Return Units

(1) General: Condensate return units shall be of the duplex pump type equipped with receiver, level controls, control panel, pumps, water level gauge glass, inlet strainer, thermometer, and pump suction isolation valves.

(2) Receiver: Receiver shall be cast iron.

(3) Pumps: Each pump shall be capable of delivering the design condensate flow rate at the appropriate discharge pressure. Design condensate flow rate shall be equal to the sum of the individual condensate flow rates connected to the receiver multiplied by a safety factor of 3. Pumps shall be of the bronze-fitted, end suction type equipped with mechanical seals rated for 210 deg. F temperature. Pumps shall also be equipped with low NPSH bronze impellers with bronze wear rings. Pump motors shall be of the open drip-proof type.

(4) Level Controls: Level controls shall include electric alternator and two (2) float switches.

(5) Control Panel: Control panels shall have a NEMA 1 enclosure. Control panels shall be equipped with motor starters, HOA switches, terminal strips, disconnect switches, running lights, alarms, and control transformers.

(U.) Thermal Expansion

(1) General: Steam piping systems shall be designed to accommodate thermal expansion using expansion loops, bends, offsets, pipe guides, and pipe anchors in accordance with standard engineering practice. If the anticipated expansion is too great to accommodate using pipe loops, bends or offsets, expansion joints may be used.

(2) Thermal Expansion: The designer shall calculate the anticipated thermal expansion based upon the pipe material, length of piping between anchors, and the anticipated change in temperature. For standard steam systems, the anticipated change in

temperature is 300 deg. F and the thermal linear expansion is 2.38 inches per 100 feet of pipe for steel pipe.

(3) Anchors: In general, anchors should be located in the center of steam risers and at the ends of long runs of piping.

(4) Loops: Expansion loop widths and heights shall be determined in accordance with standard engineering practice based upon the pipe size, pipe material, and total amount of expansion. In general, expansion loop widths shall be equal to the heights divided by 2. Reference Appendix I for expansion loop selection charts.

(5) Offsets and Bends: Expansion loop offsets and bends shall be designed in accordance with standard engineering practice based upon the length of the longest leg, length of shortest leg, pipe size, pipe material, and total amount of expansion.

(6) Guides: Pipe guides shall be located on both sides of expansion loops, offsets, and bends in accordance with standard engineering practice.

(7) Expansion Joints: In the event that thermal expansion cannot be accommodated using loops, offsets, or bends, expansion joints may be used (risers or tunnels where insufficient room exists to install a loop, for example). If used, expansion joints may be of the packed or packless type depending upon application specific requirements.

(8) Pipe Supports: In general, clevis type pipe hangers with saddles shall be used. In applications where extreme expansion is possible, roll-type hangers shall be used.

(V.) Sequences of Operation

(1) Relief Valves: EMS shall monitor the steam relief valves using strap-on temperature sensors located at the discharge of each relief valve.

(2) Steam and Condensate Flow Meters: EMS shall monitor, totalize, and record steam and condensate flows.

(3) Building Steam Pressure: EMS shall monitor the building steam pressure (low pressure only) using a steam pressure transmitter.

(4) Steam Pressure Regulating Valve Electric Pilot: Where requested by Facilities Management, steam pressure regulating valves shall be equipped with electric pilot for remote shut-off through EMS.

(5) Steam Trap Monitor: Steam trap monitor shall be connected to the EMS. An alarm shall be activated in the event of a steam trap failure.

23 22 13 STEAM AND CONDENSATE PIPING (REVISED 08/28/2018)

(A.) General

(1) Specify steam piping to be schedule 40 black steel and condensate piping to be schedule 80 black steel.

(2) Installation and insulation of the steam pressure reducing stations and relief valves must be complete for heating system to be used.

(3) On the low-pressure steam meter supply line, specify a signal conditioner driver assembly.

(4) Specify steam traps to be Bestobel thermostatic thermodynamic traps or equivalent.

(5) Specify all steam pressure regulators to be Sarco or Spence.

(6) On the supply line, the following is to be installed: One flow rate transducer, Foto Flow #BPN 835-HT, 22" through 14" insertion style, "Wet Trap" configuration, stainless steel construction, LB conduit fitting with 4 point terminal strip and complete with 12" Mueller #H10013 Corporation stop and weld sleeve for mounting on the supply line.

(7) Reference the following guidelines for procedures in cleaning hydronic, steam, and condensate piping.

(8) The contractor is to install an “Abag filter" in the steam return line that will remain in the line until the steam supply and return system is clean.

(9) Exposed lines shall run parallel with, or perpendicular to building lines and wherever possible shall be grouped together for easy service and identification. Lines that require a definite grade for drainage shall take precedence in routing over all other lines. Wherever possible, hold horizontal and vertical lines as close as possible to the walls, ceiling, struts, members, etc., so as to occupy the minimum space consistent with the proper requirements for insulation, expansion, removal of pipe and access to valves, dampers, etc. Concealed work shall finish-off within the limits permitted by the vertical or horizontal chases.

(10) Valves that are required for the control and/or isolation of any parts of the systems shall be furnished, installed, and located in an accessible position, or made accessible through removable panels, etc. Group several valves, related as to function, in a battery. Install isolation valves at the take-offs from risers at each floor. (08-28-2018)

(11) Provide swing joints, turn, expansion loops, expansion joints, or line offsets where shown on the drawings and necessary to allow for expansion. Install anchors where shown or required to control expansion of the piping system. Anchors shall be of the clamp type, securely fastened to the building structure.

(12) Use unions or flanges at connections to all equipment to facilitate dismantling, and elsewhere as required in the erection of the pipe or in the installation of valves.

(13) Make connections to rotating equipment in such manner as to prevent transmission of vibration into the piping systems.

(14) Prohibit running thread nipples.

(B.) Hangers

(1) In all cases, support piping systems from structural members. Provide suitable beam clamps. In no case, drill in any building member for pipe supporting purposes. In each case, attach an extension piece of the proper size to the beam clamp. The hanging member attached to inserts or beam clamps shall be a hanger rod having machine cut

threads at both ends. Select the length of the rods to meet the individual requirements.

(2) Hangers for pipes 2" in diameter and smaller shall be of the split cast ring type with socket, and hangers for pipe larger than 2" in diameter shall be of the adjustable clevis type. Hanger rods shall be in accordance with the schedule above. Use of trapeze hangers where groups of pipes are routed together is permitted.

(3) The spacing of hangers must depend on the size and nature of the piping system involved; therefore, no specific hanger spacing table is provided here. Under no circumstances shall hangers or supporting structures be spaced wider than 10' apart. Adequately support vertical lines at their bases, either by a suitable hanger placed in the horizontal line near the riser, or by base fitting set on a pedestal or foundation and from each floor slab by means of a clamp type support bearing on the slab or beam.

(4) Prohibit wire or perforated strap iron strap as a pipe hanger.

(C.) Sleeves

(1) Where pipes pass through walls, or floors not on grade, use 22-gauge galvanized sheet iron sleeves. In pipe chases and above ceilings, sleeves shall extend 1½" beyond each surface. Cover all sleeves, except those in pipe chases and above ceilings with chrome plated floor, wall, or ceiling plates. Size sleeves so that they readily permit the subsequent insertion of pipe of the proper size. In case of insulated lines, the diameter of the sleeves shall be at least ½" larger than the outside diameter of the insulation.

(2) Sleeves through foundation walls and slabs on grade shall be galvanized steel with a stop plate welded to sleeve and set in wall or floor. Caulk sleeves watertight with a silicone sealer.

23 25 00 HVAC WATER TREATMENT

(A.) Approved Manufacturers:

(1) Chemical treatment system shall be provided by the University of Arkansas Facilities Management Utility Department.

(2) Microtech, Inc.

(3) Mogul Corporation

(B.) Quality Assurance

(1) Chemicals, services, and equipment shall be supplied by a single water treatment company for undivided responsibility.

(2) The bid for chemicals, service, and equipment shall be as recommended and furnished by the water treatment company based upon a complete analysis of the water from the site.

(3) The water treatment company that furnishes the required chemicals and testing services shall be a recognized specialist, active in the field of industrial water treatment for at least five (5) years, whose major business is in the field of water treatment, and shall have regional water analysis laboratories, development facilities, and service department.

(4) The necessary chemical formulations and testing shall be as directed by the supplier.

(5) Mechanical contractor shall install all equipment. Water treatment contractor shall supervise the cleaning of hydronic and steam piping systems. Provide certification for each system when cleanout is completed.

(C.) Chemical Treatment

(1) General: The Contractor shall provide clean-out, preparation, pre-treatment services for steam, chilled water, and heating water piping. The Contractor shall also furnish and install chemical feeder for heating water system. On-going treatment program shall be provided by Facilities Management.

(2) Steam: Steam piping shall be treated to remove oil, grease, and other contaminants from the steam piping. Cleaner shall be circulated for a minimum of 4 hours. After cleaning, system shall be flushed to remove the cleaner.

(3) Chilled Water: Chilled water piping shall be treated to remove oil, grease, and other contaminants from the steam piping. Cleaner shall be circulated for a minimum of 4 hours. After cleaning, system shall be flushed to remove the cleaner.

(4) Heating Water: Heating water piping shall be treated to remove oil, grease, and other contaminants from the steam piping. Cleaner shall be circulated for a minimum of 4 hours. After cleaning, the system shall be flushed to remove the cleaner.

(5) Chemical Feeder: Chemical feeder shall be equipped with piping connections, drain connections, removable top, and funnel. Chemical feeder volume shall be a minimum of 2 gallons.

(6) Coordination. All power, motor, and interlock wiring required for solution pumps, timers, monitors, etc., shall be furnished, whether shown or not, at no additional cost.

(7) Coordinate exact locations and power requirements with the electrical contractor and other trades as required avoiding omissions or conflicts.

(8) Chemical Programs. Cleanout program equal to Microtech C-100. Treatment program not required.

(9) Heating Water System. Cleanout program equal to Microtech H-100. Treatment program equal to Microtech H-200.

(10) Steam and Condensate System. Cleanout program and Treatment program not required.

(11) Chemical Shot Feeder. Equal to Microtech, 4-quart, one-shot feeder, complete with isolation valves and inlet fill funnel.

(12) In Plant Testing. Provide all necessary chemical testing equipment and reagents for in-plant testing. Equipment and reagents shall be provided for each system and shall be furnished in a sturdy case labeled with system name (i.e. "Chilled Water"). Supply all log sheets, patterned after those used by the Construction Coordinator, for recording of test results and treatment used. Furnish a Vinyl covered, hardback, 3-ring binder with label on spine "WATER TREATMENT TEST LOG". Include printed instructions for each type of test and tab dividers for each section.

(13) Examination. Provide all necessary chemical testing equipment and reagents for in-plant testing. Supply all log sheets for the recording of test results of treatment used.

(14) Cleanout and Preparation for Chilled, Steam and Heating Water Piping Systems. Water treatment supplier shall supervise the cleaning and shall provide a certificate of completion of cleaning procedures. Systems shall be flushed out as additionally required by the water treatment supplier.

(15) Chilled Water System-Treatment. Install a one-shot feeder, where indicated on the drawings that meets the pressure requirements of the specified system. Provide automatic feed and monitoring systems as may be required based upon initial water analysis. Provide the chemical formulations required to inhibit scale and corrosion, together with written instructions for dosage, application procedures and testing.

(16) Steam System Treatment. Provide chemical formulation as required to control scale, sludge, and corrosion "in" steam and condensate return lines, together with written instructions for dosage, application procedures, and testing.

(17) Heating Water System-Treatment. Install a shot feeder, where indicated on the drawings, that meets the pressure requirements of the specified system. Provide automatic feed and monitoring systems as may be required based on initial water analysis. Upon placing the heating system into service, provide the chemical formations as required to inhibit scale and corrosion, together with written instructions for dosage, application procedures, and testing. Treatment levels shall be maintained at 300 to 500 ppm of nitrite residual.

(D.) References

- Reference Appendix J for sample chemical treatment specifications.
- Reference Appendix I for sample chemical treatment details including tower water system and chemical feeder.

23 30 00 HVAC AIR DISTRIBUTION (REV 11-15-2018)

(A.) General

(1) Coordinate ductwork with lighting, structural, plumbing, fire protection system, process piping, and all sources of potential conflict.

(2) Generally, design duct using the equal friction loss method.

(3) Size duct in the following systems using the static regain method:

(4) Systems of over 10,000 cfm.

(B.) Under floor duct systems.

(1) Systems in auditoriums, lecture halls, and facilities where acoustics are a concern.

(2) Run-out taps of round branch duct into rectangular trunk duct either shall be bell-mouth fittings or manufactured air scoops. Run-out taps of round branch duct into round or flat oval trunk duct shall be conical fittings. Prohibit direct stub-in of round duct taps into trunk duct. Trunk duct shall be oversized, if necessary, to accommodate the tap fitting. Do not stub or tap one supply duct into another except at the last fitting of each path of airflow. Use duct splitters, wye fittings, etc. as necessary to minimize static pressure losses. Use bellmouth fitting or manufactured scoop to tap ceiling diffuser and register run-out ducts into trunk ducts.

(3) All round duct elbows shall be full radius or five-segment type. Prohibit mitered elbows.

(4) Install butterfly dampers in the branch duct near the trunk duct tap. Locate volume control dampers in ducts rather than air distribution device.

(5) Flex duct may be used, at contractor's option, under the following conditions:

(a) Flex duct may be used to connect run-out duct-to-duct collar on diffusers.

(6) Prohibit flex duct lengths in excess of 5' under any circumstances.

(7) Flex duct bends in excess of one 90-degree turn is not permitted.

(8) Flex duct shall not be used to penetrate one, two, or four hour rated firewalls.

(9) Flexible connections shall be high temperature coated fiberglass with not less than 3" of developed length.

(10) At all places in conventional supply ductwork where a duct divides, furnish and install splitters of 16-gauge galvanized iron securely fastened to a square operating rod, and with the edges lined with felt. After completion of adjustment, the handle shall have a lock that securely holds the damper in place. If the duct is enclosed in a furring, the operating handle shall be extended and the damper regulator installed on the face of the finished surface.

(11) Install an extractor at all places where a rectangular branch duct is tapped into a rectangular trunk duct. Extractor shall be manufactured by Titus or approved equivalent. At contractor's option, 3-inch deep straightening vanes on 2" centers may be used in lieu of extractors. Contractor shall submit shop drawing of straightening vanes if he intends to use them in lieu of extractors.

(12) Fit all turns and bends in supply duct indicated on the plans as square elbows with turning blades accurately spaced and securely supported in place. The turning blades shall be factory fabricated, selected as to number and dimensions from the manufacturer's standard size selection chart, or fabricated on the job to a detail approved by the Engineer.

(13) Furnish and install an air volume control device at the supply duct branch from the main trunk duct that exactly fits the duct opening. Each volume control damper shall have a manual operator with a stem extension to extend the handle above the insulation. (Rev 11-15-2018

(14) Use butterfly dampers for round ducts. Use combination fittings that have low friction loss air scoops and butterfly dampers in lieu of separate fittings. Use opposed blade dampers for rectangular ducts.

(15) Construct all air distribution devices of sufficiently heavy gauge material that there is no splaying in the frame or warping of the core during installation, air balance, directional adjustment, or routine maintenance. Blades, cones, and accessories shall not cause any rattling noises caused by a loose fit.

(16) Use 4-way, square, concentric cone-type ceiling diffusers. Perforated and panel types are not acceptable. Supply registers shall be double deflection type. Return and exhaust grilles shall be louver face type.

(17) Generally, size all supply air distribution devices for maximum throw not to exceed a 23 dB noise level. Size return, exhaust, and transfer grilles for 400 feet per minute face velocity not to exceed a 23 dB noise level.

(18) In designing VAV systems, it is recommended that registers and diffusers be specified which are made specifically for VAV systems. In conventional systems, it is recommended that louver face diffusers, grilles, and registers be used for efficiency.

(19) All wall-mounted devices shall be impact resistant construction of extra heavy gauge steel or extruded aluminum.

(20) Underfloor duct and fittings shall be either sheet metal with factory applied four-mil thick PVC coating or constructed entirely of heavy gauge PVC plastic.

(21) Supply duct in high velocity systems shall have a silencer installed at the discharge of each air unit. At designer's option, a fabricated silencer may be used in lieu of a manufactured one as follows: 20' of double wall, high-pressure duct immediately downstream of the supply fan. Perforate the duct's inner wall and install insulation between the inner and outer walls. The duct shall be United McGill's Acousti-K or Engineer approved equal.

(22) Specify using adhesive peel-off-backing, stick-on anchors for securing insulation to duct will not be allowed. Duct insulation to be mechanically pinned to ductwork.

(C.) Submittals

Furnish manufacturer's literature and data for the following:

(1) Air control devices.

(2) Air distribution devices.

(3) Fans.

(4) Louvers.

(5) Dampers.

(6) Fire dampers.
(7) Brick vents.
(8) Relief hoods and intake hoods.
(9) Exhaust hoods (manufacturer's data or shop drawings).
(10) Underfloor duct.

(D.) Execution

(1) Rigidly support all horizontal ducts from the structure by means of straphangers. Suspending duct with wire shall not be acceptable.
(2) Workmanship shall be careful, accurate, and neat. All longitudinal seams shall be lock seams, and all cross-joints shall be "S" drive pocket or bar slip type not to exceed seven (7) feet on centers. Ductwork shall be airtight. Repair leaking joints by replacing defective sheet metal. If the leak is less than 10 CFM, Hardcast, or Mon Eco Industries sealant may, at Contractor's option, be used to seal the duct. Apply Hardcast and Mon Eco sealants according to manufacturer's recommendations. Duct tape or caulking is not acceptable for duct leak repairs.
(3) 6" wide rubberized fiberglass fabric flex connections with clinched sheet metal edging shall be used to connect ductwork to all fan powered equipment with motors ¼ horsepower and larger.
(4) Seal flexible duct to rigid duct and air distribution devices with nylon draw bands and mastic. Seal insulation vapor barrier jacket to adjacent surface with vapor barrier tape.
(5) Do not tap branch ducts into elbows of main ducts. Taps in supply duct elbows interfere with the effect of the elbow's turning vanes. Taps in return duct elbows cause a "bull-head tee" effect. Offset branch duct as necessary to tap into main duct a minimum of two (2) feet upstream or downstream of elbows. Avoid "Bull-head" tees in return ductwork by means of turning vanes or offsetting the run-outs.
(6) Do not use extractors, scoops, stub-ins, etc. as substitutes for duct splitters and vaned elbows. Due to excessive static pressure losses from multiple taps in the air's flow path, perform a tap for only the final run-out to the air distribution device.
(7) Brace exposed ductwork to prevent side-to-side movement.
(8) Flues shall comply with Arkansas Mechanical Code, NFPA 56, and local authority having jurisdiction. Extend flues a minimum of three (3) feet above the roof or three (3) feet above any obstruction within ten (10) feet horizontally.
(9) Install combustion and relief air duct in accordance with Arkansas Mechanical Code, NFPA 90A and 90B, and local authority having jurisdiction. Route combustion and relief air duct up through roof with curbs, flashing, counter-flashing, and hood or rain cap. Prohibit stubbing the ducts into the attic space. Do not consolidate combustion and relief air duct into one duct. Install separate duct for combustion air and one for relief air. Ducts shall have ¼", minimum, mesh aluminum screen across either the

intake or the discharge end of the ductwork. Install combustion and relief air duct that is directly connected to high efficiency condensing furnaces in compliance with the furnace manufacturer's guidelines.

(10) Outside air duct installation shall comply with Arkansas Mechanical Code, NFPA 90A and 90B, and local authority having jurisdiction. Route outside air duct to exterior of the building. Prohibit stubbing the duct into attic space. Locate outside air duct intake minimum 10′ from flues unless flues outlets are 3', minimum, higher than the duct intakes. Duct shall have ¼", minimum, mesh aluminum screen across the intake unless the louver or hood serving as an intake device has a screen or filter. (Rev 11-15-2018)

(11) Do not discharge exhaust air from in-line or ceiling exhaust fans into attic or ceiling space. Route exhaust duct from such fans to wall vents with backdraft dampers, soffit grilles, roof mounted rain caps, or exhaust hoods on roof. Exhaust fans and hoods shall be located 10', minimum, from any air intake device.

(12) Exhaust hoods shall be suspended by four, minimum, all-thread rods of ½″, minimum diameter. Two lengths of 2"x 2"x¼″ angle iron shall be clamped or welded on top of bottom chord of trusses or joists. Drill holes in the angles to accept the rods. Double nut the rods to the angles. Brace exhaust hoods subject to lateral movement. If practical, anchor or brace the hood to the nearest wall.

(13) Underfloor duct shall be sloped uniformly to a plenum, which shall have a means of draining moisture. All underfloor sheet metal ductwork couplings shall be slip-joint construction with a minimum 2" insertion length. Use United McGill Sealant Products to seal all couplings. Install sheet metal screws to provide mechanical strength at all couplings. Maximum screw spacing shall be 12" with a minimum of three screws per joint. Apply duct sealer on male end connectors before and after insertion to cover the entire joint and sheet metal screws. Repair any damage to the PVC coating with an acrylic lacquer paint or similar product as soon as installation of the damaged piece is completed. All underfloor PVC plastic ductwork joints and fittings shall have joint areas cleaned with solvent before cement is applied. Solvent shall be of the type and manufacturer recommended by the cement manufacturer. After cement application and joint assembly, slowly spin the joint in coupling to evenly distribute the cement until it has set up sufficiently that the joint cannot be turned by hand. If the joints have been manufactured with loose tolerances, silicone sealer may be used in lieu of cement. If silicone sealer is used, use clean joints with solvent and make sure that the joints do not drift apart during the time that the sealant is curing.

23 36 00 AIR TERMINAL UNITS (REV 11-15-2018)

(14) Air terminal units shall not be fan powered. Units shall be single duct, variable volume with hydronic reheat. In order to maintain indoor air quality, units shall provide fresh air requirements at minimum flow conditions.

(15) VAV boxes shall be manufactured by Carrier, Price, Titus, York, or Facilities Management approved equal.

(16) Include static pressure differential data in VAV box schedule.

(17) Where it is feasible, locate VAV boxes in ceiling spaces of corridors, janitor's closets, storage rooms, to avoid disrupting classes, office work, etc. during maintenance.

(18) Install at least five-duct diameter of straight duct immediately upstream of VAV boxes for the box's volume control to work properly.

(19) Suspend and level unit with four all-thread rods. Attach all-thread rods to vibration isolator with washers and double nuts.

(20) Isolate hydronic reheat coils with a ball valve. Install control valve on return water pipe between isolation valve and coil. (Rev 11-15-2018)

23 52 33 CAST IRON BOILER

- See Boiler Space CO Monitoring Standard System

(21) In the event it is not feasible to use steam from the Facilities Management central heating plant, install a boiler.

(22) Use cast iron sectional boilers for buildings up to 5,000 square feet. Use water tube boilers for buildings between 5,000 and 150,000 square feet. Water tube or firebox boilers may be used in buildings over 150,000 square feet.

(23) Buildings over 100,000 square feet in size shall have two boilers. Size each boiler for 60% of the total heating demand.

(24) In the event there is insufficient clearance for rodding the boiler's tubes, align the boiler with the boiler room's door in order that the rod can extend through the door. Install double doors that swing outward.

(25) Situate all equipment in the boiler room such that boilers, pumps, etc. can be removed without having to demolish or relocate any piping or any other equipment.

(26) Detail boiler piping and trim on Drawings.

(27) Design boiler for 30-PSI hot water service. Boiler shall be a complete packaged unit including forced draft burner, refractory lined firebox, water tube heat exchanger, gas train assembly, controls trim, draft hood, draft control, insulation, sheet metal jacket, and safety devices. Boiler shall be ASME approved and stamped "125 PSIG minimum service".

(28) Burner shall be forced draft, natural gas fired with automatic spark ignition. Burner shall be equipped for full modulation and shall have flame safeguard controls to meet or exceed UL requirements.

(29) Line firebox with 2700°F high temperature refractory.

(30) Gas train assembly shall be A.G.A. approved and shall include but not be limited to:

(a) Manual main and pilot shut off valves.

(a) Main and pilot gas pressure regulator.

(b) Two automatic gas safety shut-off valves in series.

(c) Pilot gas valve.

(31) Controls trim shall include but not be limited to:

(a) High limit controller.

(b) Operating controller.

(c) ASME rated relief valves set at or below allowable working pressure of boiler as specified.

(d) Low water cut-off mounted with drain connection.

(e) Direct reading combination pressure-temperature gauge with 4" minimum, diameter face mounted near boiler outlet.

(32) Boiler shall have a skid type base. Boiler shall have easy open, gasket doors and/or panels to facilitate maintenance and cleaning water tubes.

(33) Install boiler on 3½" housekeeping concrete pad.

(34) Located, orient, and pipe boiler such that routine maintenance may be performed upon it without having to dismantle any other equipment, devices, or piping in the boiler room.

(35) Route pipe from safety relief valve to nearest floor drain. Pipe shall be same size as relief valve connection.

(36) Install air separator, expansion tank, make-up water line, thermometers, and pressure gauges.

(37) Install chemical shot feeder on cast iron sectional boilers and chemical injection systems on water tube and firebox type boilers.

(38) Install Type "B" double-wall, galvanized sheet metal flue with rain cap. Metal gauge of the flue shall comply with latest edition of the Arkansas Mechanical Code. Extend the flue 36", minimum, above roof or tallest horizontal surface within 10'.

(39) Flush heating water piping through the boiler bypass before boiler start-up.

(40) Contractor shall perform water treatment for the initial fill of the system.

(41) Manufacturer's representative shall perform the boiler start-up.

(42) Contractor shall provide four hours of training for Facilities Management maintenance personnel on how to operate the heating water system. Manufacturer's representative shall be present during start-up. In the event it is not practical to perform the start-up and training due to seasonal considerations, the Contractor may reschedule training during winter start-up. Coordinate schedule with Facilities Management.

(43) Contractor shall provide typewritten, systematic instructions on how to start and stop the heating water system in proper sequence. Mount the instructions in a frame with a glass or clear plastic cover on the wall above the heating water pumps. Tag valves and label switches with placards as needed to identify them in the instructions.

(44) Provide field wiring schematic diagram for future reference in trouble-shooting the heating water system. The schematic shall be in a water-resistant plastic envelope and permanently located in the boiler's control panel.

23 57 00 HEAT EXCHANGERS FOR HVAC

(45) Heat exchanger shall be plate and frame unless floor space is unavailable. In the event floor space for a heat exchanger is not available or if the heat transfer is steam-to-hydronic, a tube in shell heat exchanger may be used.

(46) Heat exchanger shall be situated, oriented, and piped such that routine maintenance may be performed upon it without having to dismantle any other equipment, devices, or piping in the room where it is located.

(47) Situate all equipment in the boiler room such that boilers, pumps, etc. can be removed without having to demolish or relocate any piping or any other equipment.

(48) Detail heat exchanger piping and trim on Drawings.

(49) Plate and frame heat exchangers shall be plumbed counter-flow.

(50) Install unions/flanges, thermometers, and pressure gauges on every inlet and outlet pipe.

(51) Install heat exchanger on 3½" housekeeping concrete pad.

(52) Locate, orient, and pipe heat exchanger such that routine maintenance may be performed upon it without dismantling any other equipment, devices, or piping in the boiler room.

23 64 16 CENTRIFUGAL WATER CHILLERS

(A.) General

(1) Buildings shall have chillers installed only in the event it is not feasible to use the Facilities Management central chilled water system.

(2) Chillers up to 200 tons in size shall be semi-hermetic rotary screw type. Chillers over 200 tons shall be hermetic, single stage centrifugal type.

(3) Buildings with over 50,000 square feet shall have two chillers. Each of the two chillers shall be rated for 60% of the total load.

(4) Locate, orient, and pipe chillers such that routine maintenance may be performed upon it without dismantling any other equipment, devices, or piping in the mechanical room. Situate all equipment in the mechanical room in a manner that any one piece of equipment can be removed or replaced without disturbing other equipment.

(5) Chillers shall use HFC-134a refrigerant. Although the potential threat of toxicity from HCFC 123 is slight, Facilities Management is not willing to undertake the liability of its use.

(6) Minimum efficiency shall be 0.55 kW/ton for rotary screw type chillers and 0.35 kW/ton for centrifugal chillers.

(7) Chillers up to 800 tons shall have unit mounted Variable Frequency Drive.

(8) Install the units on a level, 5½" (six-inch nominal) thick concrete housekeeping pad with vibration isolator

(9) Route pipe from rupture disc to exterior of building. Pipe shall be same size as rupture disc connection.

(10) Install air separator, expansion tank, chemical injection system, make-up water line, thermometers, and pressure gauges.

(11) Install temperature and pressure gauges with gauge cocks on the supply and return of the chilled water and condensing water.

(12) Install the flow detection device in strict compliance with the device manufacturer's guidelines. Adjust the sensitivity of the device to the chiller manufacturer's recommended setting.

(13) Thoroughly flush the chilled water piping before starting the chiller as follows:

(a) Lock the chillers electrical disconnect in the "off" position.

(a) Temporarily remove the flow detection device and plug its inlets.

(b) Close the gauge cocks.

(c) Open chilled water bypass to the chiller, and close flow through the chiller's cooler.

(d) Run the chilled water pump and open the system's strainer every 15 minutes. Continue flushing the system until blowing down the strainer gives clear returns for a minimum of two hours.

(e) Re-install the flow detection device and open the gauge cocks.

(14) Treat the chilled water with rust inhibitor as per manufacturer's instructions.

(15) Provide field wiring schematic diagram for future reference in trouble-shooting the chilled water system. The schematic shall be in a water-resistant plastic envelope and located permanently in the chiller's control panel.

(B.) Acceptable Manufacturers & Quality Assurance

(1) Manufacturer's representative shall be present during start-up. In the event it is not practical to perform the start-up and demonstration of the chilled water system during the final inspection due to seasonal considerations, the Contractor may reschedule the start-up and demonstration to a more favorable time. Coordinate schedule with Facilities Management.

(2) Monitoring/controls shall be fully compatible with Facilities Management's existing Carrier-based system.

(3) Chillers shall be manufactured by Carrier, York, or Facilities Management approved equal.

(C.) Submittals

Submittal data shall include capacity information at the design condition stipulated, KW input, and electrical and physical characteristics.

(D.) Monitoring

Safeties shall include but not be limited to:

(1) Proof of flow on the water side. The flow detection device shall be differential pressure (DP switch) type. The device shall be of the highest possible quality. Provide complete data for the device in the submittal material.
(2) Loss of charge.
(3) Low refrigerant pressure.
(4) Low oil pressure.
(5) Refrigeration system over pressure.
(6) Compressor over current.
(7) Rapid loss of load.
(8) Freeze protections.
(9) Leaving fluid sensor failure.
(10) Accessory loss of flow.
(11) Electrical phase dropout and low voltage.
(12) Accessory compressor ground fault sensing.
(13) Compressor ground fault sensor. This sensor shall de-energize the compressor on detecting a current imbalance from primary to ground in order to prevent formation of acids from motor burnout.

23 72 00 AIR-TO-AIR ENERGY RECOVERY EQUIPMENT

(A.) Exhaust Air Energy Recovery Equipment

(1) Location: Energy recovery equipment shall be located in interior mechanical rooms or mechanical penthouses.
(2) General: Energy recovery equipment may consist of energy recovery units[33] or energy recovery air handling units[34]. In 100% outside air applications, energy recovery air handling units are preferred. In applications that with less than 100% outside air, separate energy recovery units are preferred. Energy recovery units shall be of a modular design with distinct sections. Depending upon the specific application, energy recovery units may include the following sections: outside air damper, outside air filter, ventilation fan, energy recovery equipment, ventilation damper, exhaust filter, exhaust fan, and exhaust damper.
(3) Acceptable Manufacturers: Acceptable manufacturers of energy recovery air handling units and energy recovery units are Semco, Trane, DesChamps, and Venmar.
(4) Housing: Energy recovery unit housings shall be a minimum of 2" thick. Housings shall be double wall with internal fiberglass insulation. Interior and exterior liner panels shall be solid galvanized steel.

[33] Energy recovery units are separate and distinct from the air handling units.
[34] Energy recovery air handling units are air handling units equipped with energy recovery sections.

(5) Dampers: Outside air, ventilation air, and exhaust air dampers shall be of the low leakage type. Dampers shall be interlocked with fans. Dampers shall be closed when its associated fan is not in operation.

(6) Filters: Outside air and exhaust air filters shall be of the dry media extended area type. Filters shall be MERV 7. Filters shall be equipped with sensing tubes and differential pressure gauges to monitor filter loading. Filters shall be equipped with sensing tubes and differential pressure gauges to monitor filter loading. Filters shall be furnished with magnehelic differential pressure gauges to monitor filter pressure drop and loading.

(B.) Ventilation Fans

(1) General: Ventilation fans shall be of the forward curved, backward curved, airfoil, plenum, or vaneaxial type depending upon the application.

(2) Flow Requirements: The ventilation fan design air flow requirement shall be equal to the peak building ventilation requirement plus allowances for duct leakage, energy wheel purge (if applicable), energy recovery equipment seal leakage, and future growth (if applicable). Allowances for future growth (if applicable) shall be established by Facilities Management for each application.

(3) Fan Static Pressure: The design fan static pressure shall be equal to the fan total static pressure less the fan discharge velocity pressure at the ventilation fan design air flow[35]. The energy recovery unit internal static pressure drops shall include filter, allowance for filter loading, dampers, and energy recovery section. The energy recovery unit external static pressure requirement shall be equal to the sum of the intake and discharge ductwork static pressure drops.

(4) Motor Selection: Fan motors shall be selected based upon the design fan motor brake horsepower. Fan motor horsepower ratings shall be a minimum of 110% of the design fan motor brake horsepower.

(5) Variable Frequency Drives: Ventilation fans shall be equipped with variable frequency drives. Ventilation fan variable frequency drives shall be equipped with manual bypass contactor arrangements.

(6) Other Considerations: Mechanical system designers shall select ventilation fans based upon efficiency, unloading characteristics, sound power levels, and other factors.

(7) Vibration Isolation: Ventilation fans shall be internally isolated from energy handling unit housings.

(C.) Exhaust Fans

[35] Sum of energy recovery unit internal and external static pressure drops.

(1) Laboratory Applications: In laboratory applications, energy recovery units shall not include exhaust fans. In laboratory applications, exhaust fans shall be located external to the building.

(2) General: Exhaust fans shall be of the forward curved, backward curved, airfoil, plenum, or vaneaxial type depending upon the application.

(3) Flow Requirements: The exhaust fan design air flow requirement shall be equal to the peak building exhaust requirement plus allowances for duct leakage, energy wheel purge (if applicable), energy recovery equipment seal leakage, and future growth (if applicable). Allowances for future growth (if applicable) shall be established by Facilities Management for each application.

(4) Fan Static Pressure: The design fan static pressure shall be equal to the fan total static pressure less the fan discharge velocity pressure at the exhaust fan design air flow[36]. The energy recovery unit internal static pressure drops shall include filter, allowance for filter loading, dampers, and energy recovery section. The energy recovery unit external static pressure requirement shall be equal to the sum of the intake and discharge ductwork static pressure drops.

(5) Motor Selection: Fan motors shall be selected based upon the design fan motor brake horsepower. Fan motor horsepower ratings shall be a minimum of 110% of the design fan motor brake horsepower.

(6) Variable Frequency Drives: Energy recovery unit exhaust fans shall be equipped with variable frequency drives. Exhaust fan variable frequency drives shall be equipped with manual bypass contactor arrangements.

(7) Other Considerations: Mechanical system designers shall select exhaust fans based upon efficiency, unloading characteristics, sound power levels, and other factors.

(8) Vibration Isolation: Exhaust fans shall be internally isolated from energy handling unit housings.

(D.) Energy Recovery Equipment

(1) Application: All building exhaust air shall be routed through an exhaust air energy recovery device except where specifically prohibited by the Arkansas Mechanical Code[37] or ASHRAE Standard 62.

(2) Type of Exhaust Air Energy Recovery Equipment: Types of exhaust air energy recovery equipment include runaround heat transfer coils, air-to-air heat exchangers, and enthalpy wheels. Due to their ability to recover both sensible and latent heat, enthalpy wheels are preferred for most applications. Enthalpy wheels, however, may not be suitable for some applications due to concerns regarding cross-contamination.

[36] Sum of energy recovery unit internal and external static pressure drops.

[37] Exhaust air energy recovery is not permitted for hazardous exhaust such as BSL-3 laboratories, radioisotope fume hood exhaust, and Perchloric acid fume hood exhaust. It has been verified, however, that general laboratory exhaust is not considered to be hazardous exhaust as defined by the Arkansas Mechanical Code.

Mechanical system designers shall discuss the proper type of energy recovery unit for the application with Facilities Management during the conceptual design phase of the project.

(3) Exhaust Air Energy Recovery Effectiveness: Energy recovery equipment shall be selected to maximize sensible and latent heat transfer effectiveness.

(4) Cross-Contamination: Enthalpy wheels, if used, shall be of the molecular sieve[38] type specifically designed to prevent cross-contamination.

(5) Purge: Enthalpy wheels, if used, shall be equipped with adjustable purge sections. Purge sections shall be designed to provide the proper purge air flow[39] required to prevent cross-contamination based upon the anticipated differential pressure between the exhaust air and ventilation air streams.

(6) Seal Leakage: Enthalpy wheels are equipped with seals to minimize the leakage of air between the exhaust air and ventilation air streams. Despite these seals, substantial leakage can occur. The amount of leakage shall be determined for each application based upon the anticipated differential pressure between the exhaust air and ventilation air streams and the length of the seals[40]. Ventilation fan and exhaust fan configurations shall be specifically designed such that leakage is from the ventilation air stream into the exhaust air stream.

(7) Variable Frequency Drives: Enthalpy wheels, if used, shall be of the adjustable speed type. Wheel speed modulation shall be accomplished using variable frequency drives. Wheel variable frequency drives shall be equipped with manual bypass contactors.

(8) Access Doors: Access doors shall be provided at each filter, access, and fan section.

(9) Service Lights: Service lights shall be provided in fan and access sections.

(10) Access Sections: Access sections shall be provided on each side of the exhaust air energy recovery sections.

(E.) Sequence of Operation

(1) General: Energy recovery unit sequences of operation shall be in accordance with the standard system control diagrams included in the UAF IDIQ contract for automatic temperature controls.

(2) Outside Air and Ventilation Dampers: In standard applications, outside air dampers and ventilation dampers shall be equipped with 2-position electric actuators. Dampers shall be interlocked with the ventilation fan such that the dampers are fully open when the fan is in operation and fully closed when the fan is not in operation.

(3) Exhaust Damper: In standard applications, exhaust air damper shall be equipped with 2-position electric actuator. Damper shall be interlocked with the exhaust fan such

[38] 3 or 4 angstrom molecular sieves are acceptable.
[39] The minimum purge air flow required to prevent cross-contamination is equal to the maximum wheel speed multiplied by the enthalpy wheel volume.
[40] The length of the seal is a function of the wheel diameter.

that the damper is fully open when the fan is in operation and fully closed when the fan is not in operation.

(4) Enthalpy Wheel: In standard applications, enthalpy wheel shall be started and operated whenever the ventilation fan is in operation. When the outside air temperature is above 80 deg. F, the enthalpy wheel shall be operated at full speed. When the outside air temperature is below 80 deg. F and above 50 deg. F, the enthalpy wheel shall be operated at minimum speed[41]. When the outside air temperature is below 50 deg. F and above 30 deg. F, the enthalpy wheel shall be modulated as required to maintain the entering chilled water coil temperature at setpoint. Setpoint shall be equal to the preheat coil setpoint plus 2 deg. F. When the outside air temperature is below 30 deg. F, the enthalpy wheel shall be operated at full speed. When the ventilation fan is stopped, the enthalpy wheel shall be stopped.

(5) Ventilation Fan: In standard applications, the ventilation fan shall be started and operated whenever the corresponding air handling unit supply fan is in operation. The speed of the ventilation fan shall be modulated as required to maintain the ventilation duct static pressure at setpoint. Ventilation duct static pressure setpoint shall be automatically reset from a minimum of negative 1.5 inches w.g. to a maximum of negative 0.25 inches w.g. based upon the position of the air handling unit ventilation air damper. If the ventilation damper is more than 95% open, the setpoint shall be increased. If the ventilation damper is less than 85% open, the setpoint shall be decreased. When the associated air handling unit fan is stopped, the ventilation fan shall be stopped.

(6) Exhaust Fan: In standard applications, the exhaust fan shall be started and operated whenever the ventilation fan is in operation. The speed of the exhaust fan shall be modulated as required to maintain the exhaust duct static pressure at setpoint. Exhaust duct static pressure setpoint shall be automatically reset from a minimum of negative 0.5 inches w.g. to a maximum of negative 1.5 inches w.g. based upon the position of the most open exhaust terminal damper. If the most open exhaust terminal damper is more than 95% open, the setpoint shall be increased. If the most open exhaust terminal damper is less than 85% open, the setpoint shall be decreased. When the ventilation fan is stopped, the exhaust fan shall be stopped.

(F.) References

- Reference Appendix F for a sample energy recovery unit schedule.
- Reference Appendix J for sample energy recovery unit specifications.
- Reference Appendix I for sample energy recovery unit details.

[41] Minimum wheel speed shall be as required to keep the wheel clean.

23 73 00 INDOOR CENTRAL STATION AIR HANDLING UNITS (REVISED 08/28/2018)

(A.) General

(1) Air handling unit shall be draw through type.
(2) Install return air fan if static pressure in the return duct is greater than ½" water gauge.
(3) Design air unit to have 100% outside air "free cooling" capability.
(4) Air handling unit cabinet shall be double wall construction with ¾ lb. per cu. ft. density insulation between walls. Gasket doors to each compartment and provide heavy-duty hinges and latches.
(5) Cooling coil shall be eight rows, eleven fins per inch, minimum, for safety factor and future equipment heat gain. Cooling coil and heating coil shall be copper with mechanically bonded aluminum fins. If more than two cooling coils are stacked due to casing height, each coil shall be fitted with a condensate pan in order to prevent "flooding" the bottom coil with condensate. Coat condensate pans with ½" thick foamed-in-place, cellular, insulation.
(6) Design filter section to hold 2" thick, standard sized, disposable filters.
(7) Air units that serve VAV systems shall have variable frequency drives.
(8) Mixed air plenum shall have opposed blade dampers situated in the plenum for proper air mixing.
(9) Install reheat coil downstream of cooling coil for humidity control.
(10) Provide air-handling units manufactured by Carrier, Mammoth, Temptrol, York, or Facilities Management approved equal.
(11) Submittal data shall include fan curves for each air unit.
(12) Locate and orient air units for coil and fan shaft pull clearance and air filter maintenance clearance. In the event fan room size is insufficient for such clearances, align coils shaft, and filter plenum with room's doors for access.
(13) Provide a 3½" concrete housekeeping pad under entire unit.
(14) Mount unit on spring loaded vibration isolators if the air unit does not have integral isolators.
(15) Make all connections to building's duct system with 6" minimum, wide rubberized canvas flex connectors.
(16) Coils shall be plumbed counter flow.
(17) Isolate coils with a gate or butterfly valve. Install control valve on return water pipe between isolation valve and coil. Install a Bell & Gossett "circuit setter" balancing valve #A-508 or equal to each coil.
(18) Isolate each heating and reheat coil with a gate valve. Isolate each cooling coil with a gate or butterfly valve. Install a 2-way control valve in the return pipe to coils. Each coil shall be connected to pipe with a union if pipe is 2½" or smaller. Flanges shall be used if pipe is 3" or larger.
(19) Install P-trap on condensate drain and route it to the nearest floor drain.

(20) Controls Contractor shall install smoke detectors in air units rated at 2000 CFM or greater and coordinate their function with other controls.

(B.) Acceptable Manufacturers:

(1) Air Handling Units: Acceptable manufacturers of air handling units include Trane, York, Carrier, Temtrol, and McQuay.

(2) Steam Humidifiers: Acceptable manufacturers of steam humidifiers are Armstrong and Dri-Steem.

(3) Atomizing Adiabatic Humidifiers: Acceptable manufacturers of atomizing adiabatic humidifiers are Nortec and Carel.

(4) Air Flow Measuring Stations: Acceptable manufacturers of air flow measuring stations are Ebtron or approved equal.

(C.) Air Handling Units

(1) Location: Air handling units shall be located in interior mechanical rooms or mechanical penthouses.

(2) General: Air handling units shall be of a modular design with distinct sections. Depending upon the specific application, air handling units may include the following sections: air flow measuring station (ventilation air), mixing dampers, air blender, filters, preheat coil, humidifier, preheat coil, chilled water coil, reheat coil, supply fan, and sound attenuation devices.

(3) Housing: Air handling unit housings shall be a minimum of 2" thick. Housings shall be double wall with internal fiberglass insulation. Interior and exterior liner panels shall be solid galvanized steel.

(4) Air Flow Measuring Station: The ventilation air flow shall be monitored using an air flow measuring station connected to the automatic temperature control system. Air flow measuring stations shall be of the thermal anemometer grid type.

(5) Dampers: Dampers shall be of the low leakage type with blade and jamb seals. Maximum damper leakage rate shall be specified. Air handling units shall not be equipped with isolation smoke dampers unless specifically required by the application[42].

(6) Filters: Air handling units shall be equipped with filters suitable for the application. Filters shall be of the dry media extended area type. Pre-filters shall be MERV 7. Final filters shall be MERV 14. Filters shall be equipped with sensing tubes and differential pressure gauges to monitor filter loading. Filters shall be furnished with magnehelic differential pressure gauges to monitor filter pressure drop and loading

[42] The Arkansas Mechanical Code does not require isolation smoke dampers at air handling units. Isolation smoke dampers, however, are required for manifold systems where multiple air handling units are connected to a common air distribution system.

(7) Air Blenders: Air handling units with ventilation air duct connections that are not equipped with preheat coils shall be equipped with air blenders. The air blender configuration shall be designed to ensure uniform mixing of the ventilation air and the return air prior to the chilled water coil[43].

(8) Preheat Coils: Air handling units with mixed air temperatures below 50 deg. F at the design conditions (minimum total air flow, maximum ventilation rate, and no exhaust air energy recovery) shall be equipped with steam preheat coils. Preheat coils shall be of the internal face and bypass type. Preheat coils shall be selected based upon the assumption that exhaust air energy recovery equipment (if applicable) is not operational.

(D.) Humidifiers:

(1) General: Air handling units shall be equipped with humidifiers. Humidifiers shall be of the steam dispersion or atomizing type. Humidifiers shall be located upstream of chilled water coils. Humidifiers shall be selected based upon the assumption that exhaust air energy recovery equipment (if applicable) is operational.

(2) Steam Dispersion Type: Steam dispersion humidifiers shall be designed to provide the required amount of humidification using 50 psig saturated steam. Steam dispersion humidifiers shall be furnished with steam control valve[44] and steam traps. Steam dispersion humidifiers with steam jackets shall be equipped with an electric solenoid valve in the steam jacket piping such that the jacket steam can be shut-off when humidification is not needed. Steam humidifiers shall be designed to provide the required amount of humidification within the available absorption distance.

(3) Atomizing Type: Atomizing type humidifiers may be used in large central air handling systems where humidification requirements exceed 1,000 pounds per hour. Atomizing type humidifiers shall be of the air operated or high-pressure liquid type. Atomizing type humidifiers shall be connected to a distilled water system.

(E.) Chilled Water Coils

(1) Arrangement: Chilled water coils shall be located in the draw-through position. Blow-through coil arrangements shall not be used without written approval from Facilities Management.

(2) Selection Criteria: Chilled water coils shall be selected for a maximum face velocity of 550 FPM, maximum air pressure drop of 1.25 inches w.g., and maximum water pressure

[43] HVAC Designers are cautioned to investigate mixing conditions thoroughly. If multiple air blenders are used in single air handling unit, the proper air blender configuration is dependent on the locations of the outside air and return air connections.
[44] Steam control valve actuator shall be either electronic or pneumatic depending upon the application.

drop (with 45 deg. F chilled water supply temperature and no exhaust air energy recovery) of 25 feet w.g.

(3) 45 deg. F Chilled Water Supply Temperature without Exhaust Air Energy Recovery: Chilled water coils shall be ***selected*** based upon the design heat transfer requirement with 45 deg. F chilled water supply temperature and 10 deg. F T. The design heat transfer requirement shall be determined based upon the peak air flow requirement and the calculated entering and leaving coil conditions assuming the exhaust air energy recovery equipment (if applicable) is not operational.

(4) 45 deg. F Chilled Water Supply Temperature with Exhaust Air Energy Recovery: After the chilled water coil is selected, the selected coil shall be ***rated*** for operation with 45 deg. F chilled water supply temperature and the entering air conditions associated with the operation of the exhaust air energy recovery equipment (if applicable).

(5) 38 deg. F Chilled Water Supply Temperature without Exhaust Air Energy Recovery: After the chilled water coil is selected, the selected coil shall be ***rated*** for operation with 38 deg. F chilled water supply temperature and the entering air conditions associated with a failure of the exhaust air energy recovery equipment (if applicable).

(6) 38 deg. F Chilled Water Supply Temperature with Exhaust Air Energy Recovery: After the chilled water coil is selected, the selected coil shall be ***rated*** for operation with 38 deg. F chilled water supply temperature and the entering air conditions associated with the operation of the exhaust air energy recovery equipment (if applicable).

(7) Flow Requirements: As indicated above, the mechanical designer shall determine the coil chilled water flow requirements for four (4) sets of conditions: 1) 45 deg. F chilled water supply temperature, 10 deg. F DT, and no exhaust air energy recovery; 2) 45 deg. F chilled water supply temperature with exhaust air energy recovery; 3) 38 deg. F chilled water supply temperature and no exhaust air energy recovery; and 4) 38 deg. F chilled water supply temperature with exhaust air energy recovery.

(F.) Reheat Coils

(1) Applicability: In standard HVAC applications, reheat coils in air handling units are not required and shall not be installed. Reheat coils may be required in some applications (cleanrooms). In these applications, the reheat coils shall be of the heating water type.

(2) Selection Criteria: Reheat heating water coils shall be selected for a maximum face velocity of 700 FPM, maximum air pressure drop of 0.50 inches w.g., and maximum water pressure drop (with 120 deg. F heating water supply temperature) of 15 feet w.g.

(G.) Design Conditions

(1) 120 deg. F Heating Water Supply Temperature: Reheat coils shall be ***selected*** based upon the design air flow, cooling coil leaving air temperature, design space heating temperature, and minimum space sensible cooling load. Reheat coils shall be selected based upon 120 deg. F entering water temperature and a 20 deg. F T.

(2) 180 deg. F Heating Water Supply Temperature: After the reheat coil is selected, the selected coil shall be ***rated*** for 180 deg. F heating water supply temperature.

(3) Flow Requirements: As indicated above, the mechanical designer shall determine the coil heating water flow requirements for two (2) sets of conditions: 1) 120 deg. F chilled water supply temperature and 20 deg. F T and 2) 180 deg. F heating water supply temperature.

(H.) Supply Fans

(1) General: Supply fans shall be of the forward curved, backward curved, airfoil, plenum, or vaneaxial type depending upon the application. In larger buildings[45], manifold supply fans or manifold equipment[46] shall be provided.

(2) Flow Requirements: The peak building supply air flow requirement shall be equal to the peak coincident sum of the individual zone air flow requirements with due consideration of internal load and solar gain diversity. The supply fan design air flow requirement shall be equal to the peak building supply air flow requirement plus suitable allowances for duct leakage and future growth (if applicable). Allowances for future growth (if applicable) shall be established by Facilities Management for each application.

(3) Fan Static Pressure: The design fan static pressure shall be equal to the fan total static pressure less the fan discharge velocity pressure at the supply fan design fan air flow[47]. The air handling unit internal static pressure drops shall include filters, allowances for filter loading, dampers, air blender, preheat coil, humidifier, and chilled water coil. The air handling unit external static pressure requirement shall be equal to the sum of the intake and discharge ductwork static pressure drops.

(4) Motor Selection: Fan motors shall be selected based upon the design fan motor brake horsepower. Fan motor horsepower ratings shall be a minimum of 110% of the design fan motor brake horsepower.

(5) Fan Dampers: In air handling units with multiple supply fans, dampers shall be installed at each fan. Dampers shall be interlocked with fans. Damper shall be closed when its associated fan is not in operation.

(6) Variable Frequency Drives: Each supply fan shall be equipped with a variable frequency drive. Supply fan variable frequency drives shall be equipped with manual bypass contactor arrangements[48].

(7) Other Considerations: Mechanical system designers shall select supply fans based upon efficiency, unloading characteristics, sound power levels, and other factors.

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[45] Buildings with floor areas of 20,000 SF or more.
[46] More than one (1) air handling unit is connected to the same air distribution system.
[47] Sum of air handling unit internal and external static pressure drops.
[48] Manual bypass contactor arrangements may be omitted if the air handling unit is equipped with a redundant supply fan or a manifold arrangement with a redundant air handling unit is used.

(8) Vibration Isolation: Supply fans shall be internally isolated from air handling unit housings.

(9) Silencers: Mechanical designers are encouraged to select "low noise" fans such that silencers are not required to achieve the design space noise levels. Silencers shall not be used without written approval from Facilities Management.

(10) Drain Pans: Humidifier and chilled water coil sections shall be equipped with drain pans. Drain pans shall be sloped in two (2) directions such that there is no water retained within the pan.

(11) Access Doors: Access doors shall be provided at each filter, humidifier, access, and fan section.

(12) Service Lights: Service lights shall be provided in fan, humidifier, and access sections.

(13) Access Sections: Access sections shall be provided between preheat coil, chilled water coil, and reheat coil sections.

(14) Sound Power Levels: Maximum acceptable sound power levels shall be established and scheduled for the air handling unit intake, discharge, and casing for each octave band.

(15) Air Handling Unit Isolation Dampers: Air handling unit isolation dampers are not required by the current edition of the Arkansas Mechanical Code[49]. Air handling unit isolation dampers shall not be installed unless a manifold arrangement[50] is used.

(l.) Humidifier:

(1) Steam Dispersion Type: Humidifier steam control valve shall be modulated as required to maintain the return air or exhaust air specific humidity at setpoint of 40 grains per pound[51]. Humidifier steam jacket control valves shall be opened a minimum of five (5) minutes before the humidifier steam control valve is opened. When the humidifier steam control valve has been closed for five (5) minutes, humidifier steam jacket control valve shall be closed. Humidifier steam control valve and steam jacket control valve shall be interlocked with the supply fan such that the humidifier is off whenever the supply fan is not in operation.

(2) Air Atomizing Type: Humidifier capacity shall be modulated as required to maintain the return air or exhaust air specific humidity at setpoint of 40 grains per pound. Humidifier shall be interlocked with the supply fan such that the humidifier is off whenever the supply fan is not in operation.

(3) Chilled Water Coil Control Valve: In standard applications, the chilled water coil control valve shall be modulated as required to maintain the air handling unit supply

[49] Air handling unit isolation dampers are required by NFPA 90 for large units (15,000 CFM or more). The current edition of the Arkansas Mechanical Code, however, is a version of the International Mechanical Code and does not require air handling unit isolation dampers.

[50] Multiple air handling units are connected to a common air distribution system.

[51] Equivalent to 35% RH at 72 deg. F dry bulb temperature.

temperature at setpoint. Supply temperature setpoint shall be reset from a minimum of 55 deg. F to a maximum of 65 deg. F based upon the position of the most open air terminal damper and as required to maintain the return air specific humidity at 78 grains per pound[52]. If the most open air terminal damper is more than 95% open, the supply air temperature setpoint shall be decreased. If the most open air terminal control damper is less than 90% open, the supply air temperature setpoint shall be increased. If the freezestat alarm has been activated, the chilled water control valve shall be fully open.

(4) Reheat Coil Control Valve: Reheat control valves[53] shall be modulated as required to maintain the space or return air temperature at setpoint. If the freezestat alarm has been activated, the reheat control valve shall be fully open.

(5) Supply Fan: In standard applications, supply fan speed shall be modulated as required to maintain the supply air duct static pressure[54] at setpoint. Setpoint shall be reset from an established minimum of 0.5" w.g. up to a maximum of 1.5" w.g. based upon the position of the most open air terminal damper. If the most open air terminal damper is less than 80% open, the static pressure setpoint shall be decreased. If the most open air terminal damper is more than 85% open, the static pressure setpoint shall be increased. Supply fan shall be automatically shut down by the freezestat, high static pressure switch, and fire alarm relay in the event of an alarm condition. Freezestat shall be located immediately downstream of the chilled water coil. Fire alarm relay shall be located at the air handling unit control panel.

(J.) Sequence of Operation

(1) General: Air handling unit sequences of operation shall be in accordance with the standard system control diagrams included in the UAF IDIQ contract for automatic temperature controls.

(2) Mixing Dampers: In standard applications, ventilation and return air dampers shall be modulated in sequence[55] as required to maintain the ventilation air flow rate at the ventilation rate setpoint. Ventilation rate setpoint shall be automatically reset from an established minimum setpoint up to an established maximum setpoint as required to maintain the lowest space CO_2 concentration at 1000 ppm and as required to maintain the building pressure at setpoint. Building pressure setpoint shall be automatically reset from a minimum of negative 0.02 inches w.g. at outside air temperatures of 30 deg. F and below up to a maximum of 0.02 inches w.g. at outside air temperatures of

[52] Equivalent to 60% RH at 75 deg. F dry bulb temperature.
[53] Reheat coils are not required in most applications. Reheat coils may be required in cleanroom applications where the air handling unit serves a single zone.
[54] Supply air duct static pressure sensor shall be located approximately 2/3 the distance from the air handling unit to the most remote terminal. Static pressure sensor location shall be indicated on the Contract Documents.
[55] Ventilation damper shall be fully opened before the return air damper begins to close.

80 deg. F and above. Dampers shall be interlocked with the supply fan such that the ventilation air damper is closed and the return air damper is open whenever the supply fan is not in operation.

(3) Steam Preheat Coil Control Valve and IFB Dampers: In standard applications, steam preheat coil control valve and IFB dampers shall be modulated as required to maintain the entering chilled water coil air temperature[56] at setpoint. Setpoint shall be equal to 50 deg. F. When the mixed air temperature is 35 deg. F and below, the steam preheat control valve shall be fully opened. If the freezestat alarm has been activated, the steam preheat control valve shall be fully open and the IFB dampers shall be in the face position.

(K.) References

- Reference Appendix F for a sample air handling unit schedule.
- Reference Appendix J for sample air handling unit specifications.
- Reference Appendix I for sample air handling unit details including steam preheat coil, chilled water coil, steam humidifier, heating water reheat coil, and condensate drain.

23 75 00 CUSTOM PACKAGED OUTDOOR, HVAC EQUIPMENT

(1) Makeup air unit cabinet shall be furniture grade steel with either 1) a rust-protective coating with a finish coat of baked enamel or 2) galvanized for weather resistance. Line cabinet with 1" thick, ¾ lb. per cu. ft. density duct liner. Gasket doors to each compartment and provide heavy-duty hinges and latches.

(2) Heating coil shall have freeze-resistant design specifically for make-up air heating applications. Coil shall have constant airflow and constant heating water flow. Accomplish temperature control by means of modulating face and bypass dampers. Coil shall be seamless copper with mechanically bonded aluminum fins.

(3) Cooling coil shall be seamless copper with mechanically bonded aluminum fins. Cooling coil shall be eight row, minimum, and shall have capacities scheduled on Drawings at "wet coil" conditions. If more than two cooling coils are stacked due to casing height, each coil shall be fitted with a condensate pan in order to prevent flooding the bottom coil with condensate. Coat condensate pans with ½" thick foamed-in-place, cellular, insulation. Mount cooling coil downstream of heating coil.

(4) Filter section shall be "V-bank" type designed to hold standard size, disposable filters.

(5) Operate shut-off damper by a damper motor. Motor shall close dampers whenever unit is not in use to assist in preventing "freeze-up."

[56] Downstream of the humidifier.

(6) Roof curb (if needed) shall be 12" high, minimum, and shall either be manufactured specifically for the particular unit or shall be fabricated to conform to the casing of the unit.
(7) Make-up air units shall be manufactured by Iso-mix, Wing or Engineer approved equal.
(8) Submittal data shall include fan curves for each air unit.
(9) Locate and orient air units for coil and fan shaft pull clearance and air filter maintenance clearance. In the event fan room size is insufficient for such clearances, align coils shaft, and filter plenum with room's doors for access.
(10) Provide a 3½" concrete housekeeping pad under entire unit.
(11) Mount unit on spring loaded vibration isolators if the air unit does not have integral isolators.
(12) Make all connections to the building's duct system with 6", minimum, wide rubberized canvas flex connectors.
(13) Coils shall be plumbed counterflow. If unit mounted on roof, route pipe through roof, inside of roof curb. Exposed pipe shall have heat tape installed under insulation.
(14) Isolate coils with a gate or butterfly valve. Install control valve on return water pipe between isolation valve and coil.
(15) Isolate each heating coil with a gate valve. Isolate each cooling coil with a gate or butterfly valve. Install a 2-way control valve in the return pipe to coils. Each coil shall be connected to pipe with a union if pipe is 2½" or smaller. Use flanges if pipe is 3" or larger.
(16) Install P-trap on condensate drain and route it to the nearest floor drain.
(17) Controls Contractor shall install smoke detectors in air units rated at 2000 CFM or greater and coordinate their function with other controls.

23 81 00 DECENTRALIZED UNITARY HVAC EQUIPMENT

(A.) Computer Rooms

(1) Where possible, consider using equipment that has dual cooling sources. For example, Data Aire and Liebert offer units that operate primarily on chilled water and have DX secondary systems.
(2) Specify that the Vendor shall provide a factory-trained representative during start-up.
(3) Computer room air conditioning shall be capable of being powered by an emergency generator.

23 82 19 FAN COIL UNITS

(A.) Fan Coil Units

(1) Application: Fan coils shall be used to condition building entries, stairs, lobbies, mechanical rooms, electrical rooms, and telephone/data rooms. Fan coil units with independent ventilation systems may also be used in renovations and new residence hall applications. Untreated outside air that has not been tempered and dehumidified shall not be connected to a fan coil unit.

(2) Independent Ventilation Systems: Independent ventilation systems shall utilize exhaust air energy recovery. Independent ventilation systems shall be equipped with preheat, cooling/dehumidification, and reheat capability such that the ventilation system produces "room neutral air"[57].

(3) General: Fan coil units may be horizontal exposed, horizontal concealed, or vertical exposed depending upon the specific application. Auxiliary drain pans with drains piped to a conspicuous location and moisture sensor shall be located below fan coil units installed above ceilings or other structure subject to damage in accordance with the requirements of the Arkansas Mechanical Code.

(4) Acceptable Manufacturers: Acceptable manufacturers of fan coil units are International, Trane, York, Carrier, Envirotec, and McQuay.

(5) Filters: Fan coil units shall be equipped with filters suitable for the application. Filters shall be of the dry media type.

(6) Chilled Water Coils: Chilled water coils shall be ***selected*** based upon 45 deg. F chilled water supply temperature and 10 deg. F T. After the chilled water coil is selected, the selected coil shall be ***rated*** for operation with 38 deg. F chilled water supply temperature.

(7) Heating Water Coils: Heating water coils shall be selected based upon 180 deg. F heating water supply temperature and 30 deg. F T.

(8) Fans: Fans shall be direct or belt-driven. Fans shall be of the forward curved type suitable for the application. Fan housings and impellers shall be fabricated out of metal.

(9) Fan Motors: Fan motors shall be of the 3-speed permanent split capacitor type with integral thermal overload protection.

(B.) Valve Packages:

(1) General: Fan coil units shall be furnished with factory installed valve packages. Chilled water and heating water control valves shall be shipped to the fan coil unit factory by the Automatic Temperature Control Contractor for factory installation. A full port valve (w/plug) shall be installed in the HW/CHW return line for flushing the coil.

(2) Chilled Water: Valve package for chilled water coil piping shall include isolation ball valves, drain connection with hose bibb, manual air vent, control valve (normally closed 2-way valve with electric 2-position actuator), pressure and temperature test

[57] "Room neutral" air is air at the design space conditions (approximately 72 deg. F and 50% RH).

ports at the entering and leaving coil connections and the return connection to control valve, and unions on both sides of the control valve and at the entering and leaving coil connections.

(3) Heating Water: Valve package for chilled water coil piping shall include isolation ball valves, drain connection with hose bibb, manual air vent, control valve (normally open 2-way valve with modulating electronic actuator), pressure and temperature test ports at the entering and leaving coil connections and the return connection to control valve, and unions at all connections to the control valve and at the entering and leaving coil connections.

(4) Drain Pans: Fan coil units shall be furnished with primary and secondary drain pans. Primary drain pan shall be located under the chilled water coil. Secondary drain pan shall be located under the chilled water coil piping connections. Secondary drain pan shall drain into the primary drain pan. Primary and secondary drain pans shall be sloped such that there is no standing water.

(C.) Sequence of Operation

(1) General: Fan coil unit sequences of operation shall be in accordance with the standard system control diagrams included in the UAF IDIQ contract for automatic temperature controls.

(2) Cooling: On an increase in the return air temperature above the cooling setpoint, the fan shall be started and operated at low speed and the chilled water control valve shall be opened. On a further increase in return air temperature, the supply fan speed shall be increased to medium speed. On a further increase in return air temperature, the supply fan speed shall be increased to high speed. On a decrease in return air temperature, the supply fan shall be decreased to medium speed. On a further decrease in return air temperature; the supply fan speed shall be decreased to low speed. On further decrease in return air temperature, the chilled water valve shall be closed and the fan shall be stopped.

(3) Heating: On a decrease in return air temperature below the heating setpoint, the fan shall be started and operated at low speed and the heating water control valve shall be modulated to maintain the return air.

(D.) References

- Reference the Appendix F for a sample fan coil unit schedule.
- Reference the Appendix J for sample fan coil unit specifications.
- Reference Appendix I for sample fan coil unit details including chilled water coil, heating water coil, and auxiliary drain pan.

24.00.00 - RESERVED

25.00.00 - INTEGRATED AUTOMATION

- See IDIQ – ATC diagrams (revised 04/2024)

(A.) Boiler Space CO Monitoring Standard System

(1) All spaces containing a gas fired boiler shall have a KELE KCOPR series CO monitoring system for connection to the BAS and local audible/visual alarm notification.

(2) There shall be a combination horn/strobe(Amber) station with silencing button installed in the boiler space. There shall be a combination horn/strobe(Amber) station with silencing button installed near entryways to the boiler space.

(3) In the event of a high CO level warning a signal shall be sent to the BAS and an alarm generated and routed to alert the appropriate personnel.

(4) In the event of a high CO level alarm a signal shall be sent to the BAS, an alarm generated and routed to alert the appropriate personnel, and the local horn/strobe station(s) shall be activated. Actual number and location of remotely located horn/strobe station(s) TBD by owner as part of project controls review process.

26.00.00 - ELECTRICAL

- See the UA FRONT END DOCUMENTS (downloadable zip folder) for Owner-Provided SECTION 01 78 23 OPERATIONS AND MAINTENANCE DATA. See 33 71 73 ELECTRICAL UTILITY SERVICES

26 05 00 COMMON WORK RESULTS FOR ELECTRICAL

Electrical Load Calculations: The electrical system designer shall calculate the estimated peak building demand for electricity. The calculated peak demand shall consider load diversity. The calculations shall identify the peak electrical demand associated with each energy system including air handling systems, heating water system, chilled water system, domestic hot water system, elevators, exhaust fans, interior lighting, exterior lighting, and miscellaneous equipment. The electrical system designer shall also determine the appropriate capacity of the building primary transformer.

26 05 13 MEDIUM VOLTAGE CABLES

(5) Rate all primary cables at 15,000 volts. Rate all distribution transformers at 15,000-volt primary with a nominal center tap voltage rating of 12,470 volts

(6) Specify all cables inside tunnels to be galvanized steel interlocked armor with a ground and jacket or single conductors in rigid galvanized steel conduit.

(7) All buried medium voltage electrical shall have PVC conduit encased in red concrete at 30", minimum, depth.

(8) Specify high voltage caution signs to be placed on all high voltage splice and pull boxes.

(9) All primary electrical feeder terminations in the switchgear transformer cubical, etc., shall have dead front construction.

(10) All new building construction or renovation that involves replacement or upgrade of the medium voltage switchgear or replacement of the primary transformers shall include a means of providing the building with a looped primary feed. The switch shall have a minimum of three ways: loop in, loop out, and building feed. Coordinate the design with Facilities Management to include appropriate duct bank access to the switch for future growth.

26 05 19 LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW).

(A.) Components

(1) Minimum size for all conductors other than control wiring shall be #12.

(2) Cable and wire shall be new, un-spliced, annealed copper. Aluminum conductors shall not be allowed. Cable and wire shall be stranded for sizes #8 and larger and shall be solid for sizes #10 and smaller.

(3) Insulation shall be THW, XHHW, or dual rated THHN-THWN, UL 44, 83 and 493.

(4) Controls, communication, and signal wiring shall be stranded copper and shall conform to the recommendations of the manufacturers of the particular systems. Unless otherwise specified in other sections of these specifications, size control wiring as specified for power and lighting wiring, except that the minimum size shall be not less than #16. Multi-conductor cables shall have the conductors color-coded.

(5) Splice and joint connectors shall comply with UL 486 A, B, D, and NEC.

(6) Connectors for branch circuits (#10 and smaller) shall be solderless, screw-on, reasonable pressure cable type, 600-volt, 105-degree C. with integral insulation, approved for copper conductors. The integral insulator shall have a skirt that completely covers the stripped wires.

(7) Connectors for feeder circuits shall be as follows:

(a) Connectors shall be indent, hex screw, or bolt clamp-type of high conductivity and corrosion-resistant material.

(b) Field installed compression connectors for cable sizes 250 MCM and larger shall have not less than two clamping elements or compression indents per wire.

(c) Insulation materials for splices and joints shall be approved for the particular use, location, voltage, and temperature. Insulate with not less than that of the conductor level that is being joined.

(d) Plastic electrical insulating tape shall comply with Fed Spec HH-I-595. Tape shall be flame retardant and cold weather resistant.

(8) Wire lubricant shall be suitable for the wire insulation and conduit it is used with, and shall not harden or become adhesive. Prohibit wire lubricant on wire for isolated type electrical power systems.

(B.) Execution

(1) Install all wiring in raceway systems.

(2) Install cable supports for all vertical feeders in accordance with the NEC. Provide split wedge type, which firmly clamps each individual cable and tightens due to cable weight.

(3) For panelboards, cabinets, wireways, switches, and equipment assemblies, neatly form, train, and tie the cables in individual circuits.

(4) Seal cable and wire entering a building from underground between the wire and conduit, where the cable exits the conduit, with a non-hardening approved compound.

(5) Color-code secondary service, feeder, and branch circuit conductors as follows:

PHASE	120/208 or 120/240	277/480
A	Red	Brown
B	Blue	Orange
C	Black	Yellow
Neutral	White *	Gray
Ground	Green	Green
*or white with colored (other than green) tracer.		

(6) For phase conductors #8 and larger, color code using one of the following:
   (a) Solid color compound or solid color coating.
   (b) Stripes, bands, or hash marks of color specified above.

(7) Color as specified using ¾" wide tape. Apply tape in half overlapping turns for a minimum of three inches for terminal points, and in junction boxes, pull boxes, troughs, manholes, and handholes. Apply the last two laps of tape with no tension to prevent possible unwinding. Where cable markings are covered by tape, apply tags to cable stating size and insulation type.

(8) For modifications and additions to existing wiring systems, color-coding shall conform to the existing wiring system.

(9) Splice cables and wires only in outlet boxes, junction boxes, pull boxes, manholes, or handholes. No splices shall be concealed within conduit. The number, size, and combination of conductors shall be in strict compliance with listed guidelines on the connector manufacturer's packaging. Splices and terminations shall be mechanically and electrically secure.

(10) Control voltage (24 V, maximum) conductors may be installed without conduit above lay-in ceilings with permission from local authority having jurisdiction. The following conditions must be met:

(11) Conductors shall be neatly bundled and "zip tied" to bottom chord of joists or to conduit on ten-foot intervals. Conductors shall not be laid loosely on ceiling tiles.

(12) All wiring in utility rooms and closets shall be neatly bundled and "zip tied" to nearest available strut, conduit, or pipe. Where no strut, conduit, or pipe is available, install wire in plastic raceway.

(13) Install all wiring in walls, above gypsum board ceilings, or in occupied areas that have no ceiling in conduit.

(14) Size wire sufficiently large that the voltage drop under in rush conditions does not adversely affect operation of the controls (maximum of 3% volt drop from source of power to end use).

(15) Except where otherwise required, install a separate power supply circuit for each system in order that malfunctions in any system will not affect other systems.

(16) Where power supply circuits are not shown for systems, connect them to the nearest panelboards of suitable voltages, which are intended to supply such systems and have suitable spare circuit breakers or space for installation.

(17) Install a breaker lock on the branch circuit breaker for the power supply circuit for each system to prevent accidental de-energizing of the systems.

(18) Install insulated crimp type forked lugs on control wiring that is to be connected to terminal strips. Size lugs properly for both the wire and the terminal strip. Use forked lugs unless the controls manufacturer specifies ring type.

(19) Install a permanent wire marker on each wire at each termination. Identifying numbers and letters on the wire markers shall correspond to those on the wiring diagrams used for installing the systems.

(20) In each pull box and junction box, install metal tags on each circuit cables and wires to designate clearly their circuit identification and voltage.

(21) Feeders and branch circuits shall have their insulation tested after installation and before connection to utilization devices such as fixtures, motors, or appliances. Test shall be performed by meter and conductors and shall test free from short-circuits and grounds. Test conductors' phase-to-phase and phase-to-ground. Meter motors after installation but before start-up and test free from grounds.

26 05 33 RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

(A.) Conduit

(1) Install all wiring in conduit.

(2) Conduit shall be rigid, galvanized, heavy wall steel, for sizes 2½" and larger. Conduit less than 2½" in diameter shall be electrical metallic tubing (EMT), except where installed in slabs on grade, underground, building exterior, or where prohibited by Code, in which case rigid metallic conduit as described above shall be used.

(3) At the Contractor's option, rigid aluminum conduit may be used in lieu of rigid steel conduit in sizes 2½" and larger, except aluminum conduit shall not be buried in concrete or directly in earth.

(4) At the Contractor's option, PVC conduit may be used for underground conduit runs in the horizontal portion only. Rigid metallic conduit shall be required for elbows and vertical transitions for all underground conduit installations.

(5) At the Contractor's option, conduit 2½" and larger may be electrical metallic tubing (EMT) only in interior applications where the conduit is installed concealed within the building ceiling space and non-masonry wall constructions.

(6) Conduit size shall be in accordance with the NEC, but not less than ¾" unless otherwise shown. Where permitted by the NEC, ½" flexible conduit may be used for tap connections to recessed lighting fixtures and ¾" flexible conduit may be used for tap connections to handy boxes in existing walls. (Rev 08/28/2018)

(7) Conduit shall not be required for control voltage conductors except fire alarm system wiring system shall have red anodized EMT conduit. (Rev 08/28/2018)

(B.) Hangers

(1) Design pipe straps specifically for use with electrical conduit; "plumbers' tape" shall not be accepted.

(2) Design individual conduit hangers for the purpose, having a pre-assembled closure bolt and nut, and provisions for receiving a hanger rod.

(3) Multiple conduit (trapeze) hangers shall not be less than 1½" by 1½", 12-gauge steel, cold-formed, lipped channels; with not less than (?)" diameter steel hanger rods.

(4) Solid masonry and concrete anchors shall be steel collet type. Wooden dowels and plastic type anchors shall not be acceptable.

(5) Design clamps to be used for attaching to beams, trusses, and joists. Clamps designed to be used for attaching to piping, lay-in ceiling grid, etc. shall not be acceptable.

(C.) Boxes

(1) Outlet, junction, and pull boxes shall comply with UL 50 and UL 514A. Boxes shall be cast metal where required by the NEC or shown, and equipped with rustproof box covers. Sheet metal boxes shall be galvanized steel except where otherwise shown.

(2) Wireways shall be equipped with hinged covers, except where removable covers are shown. All cover assemblies shall contain captive retaining screws.

(D.) Execution

(1) Cut holes through concrete and masonry in new and existing structures with a diamond core drill or concrete saw. Pneumatic hammer, impact electric, hand or manual hammer type drills are not allowed, except where permitted by the Engineer as required by limited working space.

(2) Where conduits, wireways, and other electrical raceways pass through fire rated partitions, firewalls, smoke partitions, or floors, install a tested and approved firestopping assembly that provides an effective barrier against the spread of fire, smoke, and gases.

(3) At floor, exterior wall, and roof conduit penetrations, completely seal clearances around the conduit and make watertight.

(4) Contractor shall furnish and install all sleeves and inserts for all electrical work passing through, or attaching to, walls, floors, or ceilings.

(5) Install essential (emergency) raceway systems independently of other raceway systems, excluding those specifically "excepted" by NEC.

(6) Install conduit as follows:

(a) Install conduit in complete runs before pulling in cables or wires.

(b) Assure conduit installation does not encroach into the ceiling height headroom, walkways, or doorways.

(c) Conduit shall be mechanically and electrically continuous.

(d) Independently support conduit. Do not support conduit with suspended ceilings, suspended ceiling supporting members, lighting fixtures, mechanical piping, or mechanical ducts.

(e) Support conduit within 12" of changes of direction, and within 12" of each enclosure to which connected.

(f) Conduit installations under fume and vent hoods are prohibited.

(7) Install conduit in concrete as follows:

(a) Conduit shall be rigid steel or EMT; except do not install EMT in concrete slabs that are in contact with soil, gravel or vapor barriers.

(b) Align and run conduit in direct lines parallel or perpendicular to building lines.

(c) Prohibit installation of conduit in concrete that is less than 3" thick.

(d) Prohibit conduit outside diameter larger than ? of the slab thickness.

(e) Space between conduits in slabs shall be approximately six conduit diameters apart, except one conduit diameter at conduit crossings.

(f) Install conduits approximately in the center of the slab so that there will be a minimum of ¾" of concrete around the conduits.

(g) Couplings and connections shall be watertight. Use thread compounds that are UL approved conductive type to ensure low resistance ground continuity through the conduits.

(8) Use flexible metal conduit for connections to motors and other electrical equipment subject to movement, vibration, misalignment, cramped quarters, or noise transmission. Provide liquid-tight flexible metal conduit for installation in exterior locations, moisture or humidity-laden atmosphere, corrosive atmosphere, water, or spray wash-down operations, and locations subject to seepage or dripping of oil, grease, or water. Provide a green ground wire with flexible metal conduit.

(9) Equip conduits 3" and larger, that are rigidly secured to the building structure on opposite sides of a building expansion joint, with expansion and deflection couplings. Install the couplings in accordance with the manufacturer's recommendations. Provide conduits smaller than 3" with junction boxes on both sides of the expansion

joint. Connect conduits to junction boxes with 15" of slack flexible conduit. Flexible conduit shall have a copper green ground bonding jumper installed. In lieu of this flexible conduit, expansion and deflection couplings as specified above for 3" and larger conduits are acceptable.

(10) Use wire mold raceway, or equal, for work on existing masonry walls in finished areas. Anchor wire mold on 30" centers. Size wire mold as per manufacturer's guidelines.

(11) In areas where Contractor is having trouble installing concealed wiring and/or conduit, consult the Architect about using wire mold.

26 05 73 OVERCURRENT PROTECTIVE DEVICE COORDINATION (ARC FLASH) STUDY

It is the intent of the University of Arkansas to comply with the Arc Flash requirements as provided for in NFPA 70E, Standard for Electrical Safety in the Workplace. The responsibilities and scope of work for design professionals and contractors for major renovation and new construction projects are to deliver to the University at the time of turnover, a system that fulfills the labeling requirements under the standard (See Appendix W for this standard), and that meet the analysis criteria as specified in IEEE Standard 1584.

(A.) Submittal Required

(1) The consultant specifications shall require the general contractor to deliver a completed arc flash study stamped by a professional engineer, complete with both electronic and hard copy report.

(2) The deliverable shall also include the electronic computer modeling files for the fault current, coordination, and arc flash calculations. The University prefers that the analysis be performed using SKM xxx, by Company, though it is not a requirement.

(3) The consultant specification shall be structured to require a two-step analysis process. The first step shall be based on the approved electrical equipment supplier submittal documents and reasonable assumptions for the installed condition. The model shall be run for the final deliverable report based on the as built condition, using actual cable lengths and the approved coordination protective device settings prior to the generation and installation of Arc Flash labeling.

(4) The University can assist during the design process to ensure that the contract documents comply with the requirements of this section. UA will provide the available fault current at the MV Service entrance based on the current version of the campus power distribution fault current & protective device coordination model.

26 09 23 LIGHTING CONTROL DEVICES

(A.) General

(1) Performance criteria and goals for sustainable and energy-efficient new and major renovation buildings to follow ASHRAE 90.1 2007, as adopted by the State of Arkansas in April 2009. Buildings must be designed, constructed, and certified to at least 10%

reduction below the baseline energy consumption determined by the performance rating method of Appendix G of ASHRAE 90.1 2007.

(2) Lighting Control Manufacturer shall be Lutron Electronics or Facilities Management approved equivalent.

(3) Wireless lighting controls shall be considered on renovation projects for system flexibility and ease of installation. Wireless shall have a minimum communication range of 30 feet through construction material and 60 feet line of sight.

(4) Warranty: Provide a minimum two-year warranty to include 100-percent replacement parts coverage and 100-percent manufacturer labor coverage to troubleshoot and diagnosis a lighting issue. Telephone technical support to be available 24 hours per day, 7 days per week, excluding manufacturer holidays.

(5) All lighting controls shall meet ANSI/ESD S20.20, NECA 130, UL 20, UL 1472, and NFPA 70. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

(6) Unless specifically indicated to be excluded, provide all required conduit, wiring, connectors, hardware, components, accessories, etc. as required for a complete operating system.

(B.) Wired Occupancy Sensors

All wired occupancy sensors shall have the following features:

(1) Capable of sensing both major motion (such as walking) and minor motion (such as small desktop level movements) according to published coverage areas, for automatic control of load indicated.

(2) Sensor technology: Passive Infrared/Ultrasonic Dual Technology

(3) Provide LED to visually indicate motion detection with separate color LED for each sensor type in dual technology units.

(4) Operation: Unless otherwise indicated, occupancy sensor to turn load on when occupant presence is detected and to turn load off when no occupant presence is detected during an adjustable turn-off delay time interval.

(5) Field configurable turn-on and hold-on activation with settings for activation by either or both sensing technologies.

(6) Turn-off Delay: Field adjustable, up to a maximum time delay setting of not less than 15 minutes and not more than 30 minutes.

(7) Power Packs for Low Voltage Occupancy Sensors: Plenum rated, self-contained low voltage class 2 transformer and relay compatible with specified low voltage occupancy sensor for switching of line voltage loads. Input supply voltage shall be dual rated for 120/277V. Provide quantity and configuration of power and slave packs with all associated wiring and accessories as required to control the load indicated on the drawings.

(8) Where wired sensors are indicated, wireless sensors are acceptable provided that all components and wiring modifications necessary for proper operation are included.

(C.) Wireless Occupancy Sensors

All wireless occupancy sensors shall have the following features:

(1) Does not require external power packs, power wiring, or communication wiring.
(2) Power: Battery-operated with minimum ten-year battery life.
(3) Capable of being placed in test mode to verify correct operation from the face of the unit. Provides a clearly visible method of indication to verify that motion is being detected during testing and that the unit is communicating to compatible RF receiving devices.
(4) Sensing Mechanism: Passive infrared (PIR) coupled with technology for sensing fine motions.
(5) Provide temporary mounting means for drop ceilings to allow user to check proper performance and relocate as needed before permanently mounting sensor. Temporary mounting method to be designed for easy, damage-free removal.
(6) Programmable to operate as an occupancy sensor (automatic-on and automatic-off), or a vacancy sensor (manual-on and automatic-off).
(7) Turn-off Delay: Field adjustable, up to a maximum time delay setting of not less than 15 minutes and not more than 30 minutes.

(D.) In-Wall Occupancy Sensors

(1) All in-wall occupancy sensors shall have the following features:
(2) Designed for installation in standard wall box at standard wall switch mounting height with a field of view of 180 degrees, integrated manual control capability, and no leakage current to load in off mode.
(3) Manual-Off Override Control: When used to turn off load while in automatic-on mode, unit to revert back to automatic mode after no occupant presence is detected during the delayed-off time interval.
(4) Passive Infrared (PIR): Capable of detecting motion within an area of 900 square feet.

(E.) Wired Daylighting Controls

All wired daylighting controls shall have the following features:

(1) System Description: Control system consisting of photo sensors and compatible control modules and power packs, contactors, or relays as required for automatic control of load indicated according to available natural light; capable of integrating with occupancy sensors and manual override controls.
(2) Daylighting Control Dimming Modules for Low Voltage Sensors: Low voltage class 2 control unit compatible with specified photo sensors and with specified dimming ballasts/drivers, for both continuous dimming of compatible dimming ballasts/drivers

and switching of compatible power packs, contactors, or relays in response to changes in measured light levels according to selected settings.

(3) Operation: Unless otherwise indicated, specified load to be continuously brightened as not enough daylight becomes available and continuously dimmed as enough daylight becomes available. Load to be turned off when available daylight is sufficient to fully dim the load.

(4) Power Packs for Low Voltage Daylighting Control Modules: Plenum rated, self-contained low voltage class 2 transformer and relay compatible with specified low voltage daylighting control modules for switching of line voltage loads. Input supply voltage shall be dual rated for 120/277V. Provide quantity and configuration of power and slave packs with all associated wiring and accessories as required to control the load indicated on the drawings.

(5) Where wired sensors are indicated, wireless sensors are acceptable provided that all components and wiring modifications necessary for proper operation are included.

(F.) Wireless Daylighting Controls

All wireless daylighting controls shall have the following features:

(1) Does not require external power packs, power wiring, or communication wiring.

(2) Power: Battery-operated with minimum ten-year battery life.

(3) Partially shielded for accurate detection of available daylight to prevent fixture lighting and horizontal light component from skewing sensor detection.

(4) Provide linear response from 2 to 150 foot-candles.

(5) Provide temporary mounting means for drop ceilings to allow user to check proper performance and relocate as needed before permanently mounting sensor. Temporary mounting method to be design for easy, damage-free removal.

(G.) Dimmers and Switches

All Wall Dimmers and Switches shall have the following features:

(1) Provide control stations of type, rating, and configuration as indicated or as required to control the loads as indicated.

(2) Surge Tolerance: Designed and tested to withstand surges of 6,000V, 200 amps according to IEEE C62.41.2 without impairment to performance.

(3) Dimmers: Provide full range, continuously variable control of light intensity.

(4) For wireless controls: Communicates directly to compatible RF receiving devices through use of a radio frequency communications link. Allows for easy reprogramming without replacing the unit. Does not require external power packs, power, or communication wiring. Capable of being mounted with a table stand or directly to a wall under a faceplate. Battery-operated with a minimum ten-year battery life.

(H.) Execution

(1) Electrical Contractor shall install products in accordance with manufacturer's instructions.
(2) Within the design intent, reasonably minor adjustments to locations of sensors may be made to optimize coverage and avoid conflicts or problems affecting coverage.
(3) Ensure that daylight sensor placement minimizes sensor view of electric light sources. Locate ceiling-mounted and luminaire-mounted daylight sensors to avoid direct view of luminaire.
(4) Manufacturer's startup services may or may not be required. Check with manufacturer.

26 24 13 SWITCHBOARDS

(A.) Submittals

Provide submittal data for the following:

(1) Housing,
(2) Buses,
(3) Breakers.

(B.) Acceptable Manufacturers

Acceptable manufacturers shall be Challenger, Cutler-Hammer, Siemens, Square D, or Facilities Management approved equal.

(C.) Standards

(1) Type 1 switchboard shall be front accessible with the following features:
  (a) Main breaker shall be individually mounted and compartmentalized.
  (b) Feeder breakers shall be panel mounted.
  (c) Section alignment shall be as shown on the manufacturers' data.
(2) Main section line and load terminals shall be accessible from front and side. Distribution section line and load terminals shall be accessible from the front. Bus connections shall be accessible from the front and end.
(3) Switchboard shall have bolted line and load connections.
(4) Wiring gutter covers shall be full height for access to wiring terminals.
(5) Provide a completely enclosed steel enclosure not less than the gauge required by the standards. The enclosure consists of the required number of vertical sections bolted together to form one metal enclosed rigid switchboard. Cover the sides, top, and rear with removable screw on sheet steel plates.
(6) Provide ventilating louvers where required to limit the temperature rise of current carrying parts. Protect all openings against entrance of falling dirt, water, or foreign matter.
(7) Buses shall be arranged for 3-phase, 4-wire distribution. Main phase buses (through bus), full size neutral bus, and ground bus shall be full capacity the entire length of the switchboard. Provide for future extensions by means of bolt holes or other approved

method. Brace the bus to withstand the available short circuit current at the particular location as shown on the drawings. No magnetic material shall be between buses to form a magnetic loop.

(8) Buses and connections shall be hard drawn copper. Bus temperature rise shall not exceed 65 ^{o} C. Current density shall not exceed 1200 amperes per square inch for copper. Size section busing based on the sum total of breakers served to permit operation of each unit at not less than 125 percent of its trip rating or 50 percent of the frame size, whichever is greater.

(9) Provide bare bus and mount on insulated bus supports. Provide neutral disconnect link to permit isolation of neutral bus from the common ground bus and service entrance conductors.

(10) Provide un-insulated ¼" x 2" copper equipment ground bus bar the length of the switchboard and secure at each section.

(11) Connect an un-insulated ¼" x 2" copper bus between the neutral and ground buses to establish the system common ground point.

(12) Provide 20%, minimum, space for future.

(13) Where draw out circuit breakers are provided, furnish a portable elevating carriage or switchboard-mounted device for installation and removal of the breakers.

(14) Control wiring shall be 600-volt class B stranded SIS. Install all control wiring complete at the factory adequately bundled and protected. Wiring across hinges and between shipping units shall be class C stranded. Size wire in accordance with NEC. Provide control circuit fuses.

(15) Main breakers shall be low voltage AC power type, dead front, stored energy with solid-state trip devices. Arcing contacts shall be renewable.

(16) Rating shall be 3-pole, 600 volts AC, 60-cycle with frame size, trip rating, system, voltage, and interrupting rating as shown on the drawings.

(17) Provide draw out mounting for breakers over 1600 amperes and where shown on the drawings. A racking mechanism shall position and hold the breaker in the connected, test, and disconnect positions. An interlock shall prevent movement into or out of the connected position unless the breaker is tripped open.

(18) Provide an indicator visible from the front of the unit to indicate whether the breaker is open or closed.

(19) Provide a mechanical trip button accessible from the front of the door to trip the breaker.

(20) Include provisions for padlocking the breaker in the open position.

(21) Manually operate breakers 1600-ampere frame size and less.

(22) Electrically operate breakers larger than 1600-ampere frame size

26 28 00 SWITCHES AND FUSES

(A.) Acceptable Manufacturers

Manufacturer shall be Challenger, Cutler-Hammer, Siemens, Square D, or Facilities Management approved equal.

(B.) Guidelines

(1) Switches shall be heavy duty, Type HD, and horsepower rated as required.
(2) Switches shall be quick-make, quick-break type in accordance with UL98, National Electrical Manufacturers Association (NEMA) KS1, and NEC.
(3) Switches shall be capable of accepting UL and NEMA standard fuses.
(4) Switches shall have the following features:
    (a) Switch shall have copper blades, which shall be visible in the OFF position.
    (b) Switch shall have an arc chute for each pole.
    (c) External operating handle shall indicate ON and OFF position and shall have lock-open padlocking provisions.
    (d) Mechanical interlock shall permit opening of the door only when the switch is in the OFF position.
    (e) Fuse mounting shall be for the size and type of fuses shown on the drawings. Furnish switches completely fused. Furnish a complete set of spare fuses for each switch being installed. Deliver to the Construction Coordinator additional sets of spare fuses to constitute not less than two complete sets for the type, size, and rating of each set installed.
    (f) Switch shall have a solid neutral for each switch being installed in a circuit that included a neutral conductor.
    (g) Switch shall have grounding Lug for connection of the grounding conductor.
(5) Enclosures shall be the NEMA types shown on the drawings for the switches. Where the types of switch enclosures are not shown, they shall be the NEMA types that are most suitable for the environmental conditions where the switches are being installed.

26 29 23 VARIABLE FREQUENCY MOTOR CONTROLLERS

(A.) Basic Requirements (Rev 11-15-2018)

(1) Need for bypass
(2) Hardware points
(3) Software points
(4) BACNet or ModBus

(B.) Acceptable Manufacturers

(1) Manufacturer shall be Danfoss or Facilities Management approved equal.
(2) Manufacturer shall furnish maintenance of controller for one year from Date of Substantial Completion.

(C.) IDIQ Coordination

Variable frequency drives may be one of the commodity items available through the UA IDIQ procurement system. The consultant should inquire with Facilities Management about the current status of procurement.

(D.) Guidelines

(1) Variable frequency controller shall be UL listed and shall conform to latest standards of ANSI and IEEE requirements.

(2) Power line noise limitations shall comply with IEEE Standard 519-1981, Guide for Harmonic Control and Reactive Compensation of Static Power Converters.

(3) The controller shall comply with FCC Rules and Regulations, Part 15, Subpart J for emissions of conducted and radiated RFI.

(4) Contractor shall provide manual for starting and operating controllers, complete with operating limits, wiring diagram, and maintenance schedule.

(5) The controller shall have capability of allowing the motor to be disconnected at the safety "disconnect" switch without damage to the controller's electronics.

(6) Controller shall have a displacement power factor of 0.95 or greater, lagging over entire range of operating speed and load.

(7) Minimum efficiency at full load shall be 96 percent.

(8) Additional required features shall be as follows:

(a) Controller shall have integral digital display to indicate voltage, output frequency, and output current.

(b) Controller shall have status indicators for over-current, over-voltage, ground fault, over-temperature, and input power ON.

(c) Unit shall have current limit adjustment from zero to 100 percent of rated load.

(d) Both acceleration and deceleration rate shall be adjustable from three to 60 seconds.

(e) Unit shall have HAND-OFF-AUTOMATIC switch and manual speed control.

(f) Provide terminal for remote contact to allow starting under both manual and automatic modes.

(g) Provide a manual bypass, overload motor protection, short circuit protection for full voltage, non-reversing operation of the motor. Include isolation switch to allow maintenance of inverter during bypass operation.

(h) Include integral fused disconnect switch on the line side of each controller.

(i) Controller shall have internal 115-volt control power with transformer and protective fuses.

(j) Cabinet shall have door mounted speed indicator and ammeter.

(k) Drive shall have automatic restart capability after power failures.

(l) Unit shall have a diagnostic panel consisting of LED indicators of the following conditions: over voltage, under voltage, over current, underload timer on, run,

fault, auto/manual, clipper, 6 inverter, input bus charged, input surge cycle complete, and output bus charged.

(9) Contractor shall provide two of each type of air filter and three of each size and type of fuse.

26 30 00 – FACILITY ELECTRICAL POWER GENERATING AND STORING EQUIPMENT

Discuss strategy for EM Power w/ Generator VS Central Battery unit / w/ EM Secondary less ATS VS Individual battery units.

(A.) Generator Set

(1) UA Prefers generator set over or in addition to UPS when budget allows.
(2) Preferred fuel source: Natural Gas Engine
(3) Serve the following systems typical:
  (a) Emergency Lighting
  (b) Fire pumps
  (c) Elevators and elevator pumps
  (d) Refrigerators and Freezers – Kitchen environments
  (e) Refrigerators and Freezers – Lab environments
  (f) Ventilation systems
    i. Serving animal habitats.
    ii. Serving computer rooms/technology closets
  (g) Electronic Door locks to critical/high risk areas including
    i. HR and Administration offices
    ii. Data Centers
  (h) Critical medical equipment/areas as required by code

(B.) Uninterrupted Power Supply (UPS)

(1) Preferred type: (online double-conversion) (Line-interactive) (offline)
(2) Serve the following:
  (a) Emergency response computers/alarm systems
  (a) Telecommunications equipment
  (b) Data centers
  (c) Other critical hardware

26 50 00 - LIGHTING

(3) Submit all lighting for review and approval by Facilities Management.
(4) Submit fixture and dimming information with Plan Review and Submittals.

(A.) Vault lighting

(1) Install (2) ceiling mounted units inside the vault – Canlet Ceiling Mount 68-02IFC(screw base) -01-OG-09 [ceiling mount, with incandescent screw base, with clear glass globe and cage guard]

(2) Install (1) wall mounted unit outside in the pit – Canlet Wall Mount 68-02IWF-01-01-01 + 68WME02 [wall mount, with incandescent screw base, with reflector, clear glass globe and cage guard with white reflector + wall mount extension bracket]

(3) Lighting should be switched from inside the vault on the line side of the GFCI if that is allowed so that nuisance trips on the GFCI do not kill the lighting.

(4) We do want CFL lighting but not with a separate ballast. We don't really want to use fixed ballast fixtures, but rather screw base CFLs. Otherwise, when a ballast fails, we have to get an electrician to fix it as opposed to just changing the bulb.

(B.) Interior Lighting

(1) Lighting levels should not exceed the minimum recommended by the IES guideline.

(2) The recommended lighting energy allowance is no greater than two watts per building gross square feet.

(3) Use "Lay-in" mounted light fixtures in areas that have suspended acoustic tile ceilings.

(4) In areas requiring a dimmer system, provide 0-10V dimmers.

(5) No lights shall be located over stairwells. Lights shall be over landings, or wall mounted only.

(6) Basis of Design – Campus Standard

(a) **Lay-in luminaire**: *Coronet* side basket direct/indirect *TDSW LED* or equal. Size: 2 x 2 or 2 x 4. Color Temp: 3500K max.

(a) **Exit Signage**: *Cooper Lighting Sure-Lites ES Series* or equal. Recessed ceiling mount is preferred.

(C.) Exterior Lighting

(1) Use campus standard exterior light fixtures. Cut sheets for approved fixtures are included in folder "Campus Furnishings Standards" of this Guide.

(2) Provide a photometric analysis for all exterior lighting layouts, and submit to Facilities Management Planning Group for approval. Photometrics should follow the campus lighting guidelines as established in Part Two: Planning Guidelines, Section 2.1 C (see Facilities Management, Planning Group web page).

(3) Pole lighting voltage shall be either 208 or 460. 120-volt pole lighting is unacceptable. Voltage drop in lighting circuits shall not exceed 7%.

(4) Exact location of exterior light fixtures shall be coordinated with Facilities Management Planning Group.

(5) No up lighting allowed.

27.00.00 – COMMUNICATIONS

- See the UA FRONT END DOCUMENTS (downloadable zip folder) for Owner-Provided SECTION 01 78 23 OPERATIONS AND MAINTENANCE DATA.
- See Criteria for Communications Infrastructure (.pdf)
- See Uninterrupted Power Supply (UPS)

(A.) Compliance

Design and installation shall comply with the current edition of the applicable codes including but not limited to:

(1) NFPA 70 – National Electrical Code, current version adopted by local or State AHJ.
(2) ANSI/TIA/EIA - 607: Commercial Building Grounding and Bonding Requirements for Telecommunications.
(3) TIA-310- D Cabinets, Rack, and Associated Equipment
(4) ANSI/TIA/EIA - 568 B: Commercial Building Telecommunications Cabling Standard.
(5) ANSI/TIA/EIA - 569: Commercial Building Standard for Telecommunication Pathways and Spaces.
(6) ANSI/TIA/EIA - 606: The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.
(7) ANSI/TIA/EIA - 606A: Administration Standard for Commercial Telecommunications Infrastructure.
(8) IEEE 241 - IEEE Recommended Practice for Electric Power Systems in Commercial Buildings" pertaining to communication systems.
(9) ISO/IEC IS 11801: Generic Cabling for Customer Premises
(10) J-STD-607-A – Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications, current version.
(11) TIA/EIA - TSB67: Transmission Performance Specifications for Field Testing of Unshielded Twisted Pair Cabling Systems.

27 05 53 IDENTIFICATIONS FOR COMMUNICATIONS SYSTEMS

Please check with Facilities Management for the most current color convention for cabling.

(6) Data Cables shall be lime green in color (revised 12/2023)
(7) Data jacks shall be lime green in color
(8) Phone cables shall be white in color
(9) Phone jacks shall be ivory in color

27 10 00 STRUCTURED CABLING

(A.) General

The Contractor shall be responsible for:

(1) Providing all additional materials, and the necessary labor and services required to ensure all components of the system are completely installed in accordance with the intent of the Contract Documents.

(2) Furnishing and installing all incidental items not actually shown or specified, but which are required by good practice to provide complete functional systems.

(3) Coordinating the details of facility equipment and construction for all specification divisions that affect the work covered under this Division.

(4) Coordinating all activities with the overall construction schedule.

(5) Developing bill of materials, perform material management and efficient use of the materials whether they are issued by the Contractor, the owner or purchased by the Contractor.

(6) Ensure materials in excess of those required to complete the project are kept in their original condition and packaging for restocking.

(7) Ensure project is properly registered for a warranty.

(B.) Warranty

(1) The contractor shall provide a manufacturer's warranty on the horizontal and backbone systems as specified in Section 271300 and 271500.

(2) In addition to the standard warranty requirements, the Certified Contractor shall provide the following during the warranty period:

(3) Within 24 hours after notification of a defect, the Certified Contractor shall start to make the necessary corrections and inform the appropriate Project Manager of the planned corrective actions. The Certified Contractor shall follow this initial contact with continuous effort and complete any required corrective work within 15 days after notification.

27 11 00 COMMUNICATIONS EQUIPMENT ROOM FITTINGS

(A.) General

(1) The communications equipment room will be referred as Telecommunications Room (TR) in this document is intended to house racks, cabinets and equipment necessary for the support of the communications cabling infrastructure.

(2) Telecommunications backboards. AC-rated plywood, fire-retardant treated, 3/4 inches by 48 inches by 96 inches (19 by 1220 by 2440 mm).

(3) Provide enough space for networking and networking related equipment. Telecommunication closet may house the main distribution frame, PBXs, secondary voltage protection, etc.

(B.) Product Approvals and Substitutions

(1) All products shall be provided as specified, without exception, unless approved in writing prior to the bid as per Section 012500 – Substitution Procedures.

(2) All products shall be "NEW".

(3) Non-compliant products installed as a part of this Contract shall be removed and replaced and all costs for removal and replacement shall be borne solely by the Contractor.

27 13 00 COMMUNICATIONS BACKBONE CABLING

(A.) General

(1) This Section specifies the requirements necessary to furnish and install an inter-building and intra-building twisted-pair and fiber optic cable distribution subsystem including:

(2) Cabling, splice closures, and related components.

(3) Placement, splicing, termination, and other required services.

(4) Interbuilding Backbone: The interbuilding subsystem refers to all twisted-pair and fiber optic backbone communications cabling connecting the Main Building Equipment Room (BER) to each building equipment room (BER) in all buildings on the campus.

(5) Intrabuilding Backbone: The intrabuilding subsystem refers to all twisted-pair and fiber optic backbone communications cabling connecting the Main Telecommunications Room (TR) to each Telecommunication Room (TR) in the building.

(6) Backbone cabling consists of copper and optical fiber cables and associated connecting hardware.

(7) Contractor shall furnish and install all materials necessary for a complete and working system.

(8) Field terminated optical fiber jumpers shall not be allowed.

(B.) Warranty

(1) Telecommunications contractor shall administer the warranty process with the responsible manufacturer's representative.

(2) All necessary documentation that must be provided to the manufacturer will be furnished by the Telecommunications contractor immediately following 100% testing of all cables.

(C.) Product Approvals and Substitutions

(1) All products shall be provided as specified, without exception, unless approved in writing prior to the bid.

(2) All products shall be "NEW".

(3) Non-compliant products installed as a part of this Contract shall be removed and replaced and all costs for removal and replacement shall be borne solely by the Contractor(s).

(D.) Interbuilding Fiber Optic Cable

(1) Loose Tube dielectric multimode/single-mode Fiber optic cable:

(2) All-Dry Flame Rated Optical Cable constructed of buffer tubes stranded around a dielectric strength member. Buffer tubes shall use a dry water blocking technology that does not rely upon yarns, binders, or tapes. Must be suitable for underground conduit, direct burial or Arial applications. Optical fibers shall be laser optimized 50/125-µm optical fiber having a minimum Effective Modal Bandwidth (EMB) of 2000 MHz•km at 850 nm (ANSI/EIA/TIA-492AAAC-A) or Low Water Peak Dispersion Unshifted Single-mode fiber (ANSI/EIA/TIA-492CAAB).

(3) Outside Plant Loose Tube dielectric multimode Fiber optic cable:

(4) Outside plant Optical Cable constructed of gel filled buffer tubes stranded around a dielectric strength member. Must be suitable for underground conduit, direct burial or Aerial applications. Optical fibers shall be laser optimized 50/125-µm optical fiber having a minimum Effective Modal Bandwidth (EMB) of 2000 MHz•km at 850 nm (ANSI/EIA/TIA-492AAAC-A) or Low Water Peak Dispersion Unshifted Single-mode fiber (ANSI/EIA/TIA-492CAAB).

(E.) Intrabuilding Multipair Unshielded Twisted Pair

(1) General purpose 4 pair category 3 unshielded twisted pair
   a. Twisted-pair cable with 24-AWG solid conductor, 4-pair, 100-ohm unshielded twisted-pair core covered by a PVC outer jacket. CMP Rated.

(2) General purpose 25 pair category 3 unshielded twisted pair
   a. Twisted-pair cable with 24-AWG solid conductor, 100-ohm unshielded twisted-pair core covered by a PVC outer jacket. CMP Rated.

(3) General purpose 50 pair category 3 unshielded twisted pair
   a. Twisted-pair cable with 24-AWG solid conductor, 100-ohm unshielded twisted-pair core covered by a PVC outer jacket. CMP Rated.

(4) General purpose 100 pair category 3 unshielded twisted pair
   a. Twisted-pair cable with 24-AWG solid conductor, 100-ohm unshielded twisted-pair core covered by a PVC outer jacket. CMP Rated.

(5) General purpose 200 pair category 3 unshielded twisted pair
   a. Twisted-pair cable with 24-AWG solid conductor, 100-ohm unshielded twisted-pair core covered by a PVC outer jacket. CMP Rated

(6) General purpose 300 pair category 3 unshielded twisted pair
   a. Twisted-pair cable with 24-AWG solid conductor, 100-ohm unshielded twisted-pair core covered by a PVC outer jacket. CMP Rated.

(7) General purpose 400 pair Type III unshielded twisted pair
   a. Twisted-pair cable with 24-AWG solid conductor, 100-ohm unshielded twisted-pair core covered by a PVC outer jacket. CMP Rated.

(8) Augmented category 6 unshielded twisted pair (NetCLear GTX or Leviton)

(9) 100-ohm, Category 6a, 23 AWG, 4-pair unshielded twisted pair,

(a) Maximum insertion loss of 2.0 dB/100M at 1 MHz, 19.0 dB/100M at 100 MHz, 31.0 dB/100M at 250 MHz and 45.3 dB/100m at 500 MHz
(b) Minimum PSNEXT of 72.3 dB at 1 MHz, 42.3 dB at 100 MHz, 36.3 dB at 250 MHz and 31.2 dB at 500 MHz
(c) Cable balance: LCL/TCL greater than 50 dB @ 100 m at 1 MHz, 30.0 dB @ 100m at 100 MHz and 26.0 dB @ 250 MHz. EL TCTL greater than 30 dB @ 100m at 1 MHz, and 5.5 dB @ 100m at 31.25 MHz
(d) Minimum PS-ANEXT of 80.0 dB at 1 MHz, 60.0 dB at 100 MHz, 54.0 dB at 250 MHz and 49.5 dB at 500 MHz.
(e) Minimum PS-AELFEXT of 77.0 dB at 1 MHz, 37.0 dB at 100 MHz, 29.0 dB at 250 MHz and 23.0 dB at 500 MHz.
(f) Electrical characteristics must be characterized to 750 MHz.
(g) Cable must be third party verified by ETL.
(h) 0.300-inch max cable diameter

(10) 100-ohm, Category 6a, 23AWG, 4-pair unshielded twisted pair,
(a) Maximum insertion loss of 2.0 dB/100M at 1 MHz, 19.0 dB/100M at 100 MHz, 31.0 dB/100M at 250 MHz and 45.3 dB/100m at 500 MHz.
(b) Minimum PSNEXT of 72.3 dB at 1 MHz, 42.3 dB at 100 MHz, 36.3 dB at 250 MHz and 31.2 dB at 50o MHz.
(c) Cable balance: LCL/TCL greater than 50 dB @ 100 m at 1 MHz, 30.0 dB @ 100m at 100 MHz and 26.0 dB @ 250 MHz. EL TCTL greater than 30 dB @ 100m at 1 MHz, and 5.5 dB @ 100m at 31.25 MHz
(d) Minimum PS-ANEXT of 80.0 dB at 1 MHz, 60.0 dB at 100 MHz, 54.0 dB at 250 MHz and 49.5 dB at 500 MHz.
(e) Minimum PS-AELFEXT of 77.0 dB at 1 MHz, 37.0 dB at 100 MHz, 29.0 dB at 250 MHz and 23.0 dB at 500 MHz.
(f) Electrical characteristics must be characterized to 750 MHz.
(g) Cable must be third party verified by ETL.
(h) 0.310 inch cable diameter

(F.) Intrabuilding and Interbuilding Fiber Optic Cable

(1) Loose Tube dielectric indoor/outdoor multimode/singlemode Fiber optic cable:
(2) All-Dry Flame Rated Optical Cable constructed of buffer tubes stranded around a dielectric strength member. Buffer tubes shall use a dry water blocking technology that does not rely upon yarns, binders, or tapes. Must be suitable for underground conduit, direct burial or Arial applications. Optical fibers shall be laser optimized 50/125-µm optical fiber having a minimum Effective Modal Bandwidth (EMB) of 2000 MHz•km at 850 nm (ANSI/EIA/TIA-492AAAC-A) or Low Water Peak Dispersion Unshifted Single-mode fiber (ANSI/EIA/TIA-492CAAB).
(3) Tight Buffer indoor multimode/singlemode Fiber optic cable:

(4) Tight Buffer Flame Rated Optical Cable. Optical fibers shall be laser optimized 50/125-µm optical fiber having a minimum Effective Modal Bandwidth (EMB) of 2000 MHz•km at 850 nm (ANSI/EIA/TIA-492AAAC-A) or Low Water Peak Dispersion Unshifted Single-mode fiber (ANSI/EIA/TIA-492CAAB).

(5) Interconnect Tight Buffer dielectric indoor multimode/single-mode Fiber optic cable:

(6) Flame Rated Optical Cable Optical fibers shall be laser optimized 50/125-µm optical fiber having a minimum Effective Modal Bandwidth (EMB) of 2000 MHz•km at 850 nm (ANSI/EIA/TIA-492AAAC-A) or Low Water Peak Dispersion Unshifted Single-mode fiber (ANSI/EIA/TIA-492CAAB).

27 15 00 COMMUNICATIONS HORIZONTAL CABLING

(A.) General

(1) Horizontal (distribution) communications wiring and connecting hardware from the Telecommunications Room (TR) to Telecommunication Outlets (TO) throughout the site.

(2) The horizontal distribution subsystem refers to all intra-building twisted-pair and fiber optic communications cabling connecting Telecommunication Rooms (TR's) to telecommunication outlets (TO's) located at individual work areas.

(3) Horizontal cabling may consist of a combination of the following types of cable from the TR to the TO:

(a) Augmented Category 6, Enhanced Category 6, Category 6, Enhanced Category 5e, (100 Ohm, 4-pair, unshielded twisted pair) cables from the TR's to the TO's.) Port 1 or Port 2

(b) 62.5/125 m, 50/125 m, or 850 nm Laser Optimized 50/125 m optical fiber cable. Port 2

(c) The Horizontal System includes cables, jacks, patch panels, connecting blocks, patch cords, fiber connectors and jumpers as well as the necessary support systems, such as cable managers and faceplates.

(d) Cables may be routed through conduit, cable trays, spaces below raised floors, open ceiling areas, non-ventilated spaces above ceiling tile, and through plenum air-handling spaces above ceiling tile. Coordinate with General Contractor (GC).

(e) Telecommunications contractor shall furnish and install all materials necessary for a complete and working system.

(B.) Warranty

Telecommunications Contractor shall administer the warranty process with the responsible manufacturer's representative. The warranty shall be provided directly to the owner from the manufacturer. Telecommunications contractor shall insure that the manufacturer provides the Owner with the appropriate warranty certification within 30 calendar days of the final project completion.

(C.) Product Approvals and substitutions

(1) All products shall be provided as specified, without exception, unless approved in writing prior to the bid.
(2) Non-compliant products installed as a part of this Contract shall be removed and replaced and all costs for removal and replacement shall be borne solely by the Contractor(s).
(3) All products shall be "NEW".

27 16 00 COMMUNICATIONS CONNECTING CORDS, DEVICES AND ADAPTORS

(A.) General

This section applies to any device that is a portion of the cabling channel that is connected to a work area outlet/ telecommunication outlet (TO) and at the equipment racks/cabinets.

(B.) Warranty

Telecommunications contractor shall administer the warranty process with the responsible manufacturer's representative. The warranty shall be provided directly to the owner from the manufacturer. Telecommunications contractor shall insure that the manufacturer provides the Owner with the appropriate warranty certification within 90 calendar days of the final project completion.

(C.) Product Approvals and Substitutions

(1) All products shall be provided as specified, without exception, unless approved in writing prior to the bid.
(2) All products shall be "NEW".
(3) Non-compliant products installed as a part of this Contract shall be removed and replaced and all costs for removal and replacement shall be borne solely by the Contractor(s).

27 20 00 DATA COMMUNICATIONS

(A.) General

Provide data drops for each vending machine in a vending area, compatible with the University card system.

(B.) Submittals

(1) Submit manufacturer's technical data sheets including complete installation information, performance specifications and wiring diagrams for each system.
(2) The Contractor shall provide shop drawing submittal information for review. Do not order materials until the Engineer has approved the shop drawings and submittals. Provide each of the following for review:
    (a) Material and equipment submittals for each item.

(b) A cable routing and grouping plan.
(c) Proposed wall termination block/wire management elevations, to scale, for each backboard in each communications closet.
(d) A list of proposed test equipment for use in verifying the installation of the cabling system.
(e) Manufacturer documentation showing date and outcome of last recalibration. Testing device shall have been re-calibrated within the last six months.
(f) Manufacturer documentation showing software revision. Software revision shall be most current version available for device and based upon the most current TIA/EIA testing guidelines.
(g) Proposed Category 6 UTP cable and fiber optic cable test forms.
(h) Operating and maintenance instructions for each device in the system. These instructions shall detail how to install and service the equipment and shall include all information necessary for rough-in preparation for the building facilities to receive the materials. At the completion of the project, update the operating and maintenance information to reflect any changes during the course of construction, and shall be provided to the owner in a binder labeled with the project name and description. Provide three copies of the operating and maintenance information.

(C.) Quality Control

(1) Prior to bidding the project, the Contractor shall be trained and certified by the manufacturer to install, test, and maintain the systems and shall be certified by the manufacturer to provide the manufacturer's products, performance, and application warranty.
(2) The Contractor shall employ a minimum of one Register Communications Distribution Designer (RCDD) certified by the Building Industry Consulting Service International (BICSI). The RCDD shall be a direct employee of the Contractor. The RCDD shall inspect the work in progress and shall certify the work at the completion of the project.
(3) The Contractor shall have employees directly involved with the supervision, installation, and testing of the data systems trained and certified by the supplier for Communication for installation and testing.
(4) The Contractor shall have a minimum of three years' experience installing data cabling systems.
(5) During construction, the Contractor shall periodically review installation progress for conformation to TIA/EIA and BICSI installation standards. The Contractor shall provide an official, written report to the Engineer that details the work reviewed and verifies that the work conforms to all applicable TIA/EIA and BICSI installation standards.
(6) After substantial completion and prior to Owner's acceptance, the Contractor shall certify in writing on company letterhead that the completed installation meets or

exceeds TIA/EIA and BICSI installation standards. The written certification shall be complete with the RCDD's stamp/certification number and shall bear the RCDD's signature across the face of the stamp.

(D.) Warranty

(1) The Contractor shall provide a manufacturer 15-year product, performance, application, and labor warranty. This warranty shall guarantee against defects in materials and workmanship (extended product warranty) for a period of 15 years. All cabling components of the installed systems will meet or exceed the specification of TIA/EIA 568 B and ISO/IEC 11801 (performance warranty) for a period of 15 years.

(2) All shielded and unshielded twisted pair cabling links/channels will meet or exceed the attenuation and NEXT requirements of TIA/EIA TSB 67 and ISO.IEC 11801 (performance warranty) for a period of 15 years.

(3) All fiber links/channels shall meet or exceed the loss and bandwidth requirements of TIA/EIA TSB 67 and ISO/IEC 11801 (performance warranty) for a period of 15 years.

(4) The system shall be application independent and shall support both current and future applications that use the TIA/EIA 568 B or ISO/IEC 11801 component and link/channel specifications for cabling (application warranty) for a period of 15 years.

(5) Supply all labor attributable to and required by the above at no additional cost to the owner for a period of 15 years.

(6) The warranty period shall begin on the date of substantial completion.

(E.) Execution

(1) Install freestanding EIA standard universal 19" wide equipment racks, sized at 7' at location indicated on Drawings. Install racks with mounting holes on both sides and provide with top angles, self-supporting bases and grounding kit.

(2) Wall mounted racks shall be mounted on a backboard and provided with a ground kit.

(3) Install fiber patch panels to accommodate multimedia fiber optic cable as indicated on the Drawings

(4) Modular equipment manufacturer shall furnish workstation outlets.

(5) All cabling shall bear plenum or riser related markings for the environment in which installed.

(6) Install Category 6 cable for data ports. Install one cable per 8-position communications jacks on a given workstation outlet. Category 6 cables shall meet or exceed TIA/EIA 568 B Category 6 specifications for performance, shall be part of the UL LAN Certification and follow-up program, defined by the manufacturer as an "extended performance Category 6 cable."

(7) Install fiber optic riser cable for data backbones as indicated on the Drawings. Terminate all multimode fiber strands with Duplex SC-style connectors. Fiber optic

cables shall meet or exceed standard for 100Mbps transmission. Multimode fiber optic cable shall be 62.5/125 micron graded index, tight buffered.

(8) Label shall be as recommended in TIA/EIA 606. Labels shall be permanent and legible as created by a Brady #LS-2000 label maker or equivalent. Handwritten labels are not acceptable. Labels shall be required for communications closets, riser cables, communication jacks, termination block columns for workstations and riser cables, termination strip pairs, and grounding bus bars.

27 30 00 VOICE COMMUNICATIONS

(A.) Submittals

Provide each of the following for review:

(1) Cable routing and grouping plan.

(2) Proposed wall termination block/wire management elevations, to scale, for each backboard in each communications closet.

(3) Provide operating and maintenance instructions for each device in the system. These instructions shall detail how to install and service the equipment and include all information necessary for rough-in preparation for the building facilities to receive the materials. At the completion of the project, update the operating and maintenance information to reflect any changes during the course of construction, and provide to owner in a binder labeled with the project name and description.

(4) Provide three copies of the operating and maintenance information.

(B.) Warranty

(1) The Contractor shall provide a manufacturer endorsed and backed extended 15-year product, performance, application, and labor warranty, which shall warrant the following:

(1) Warrant against defects in materials and workmanship (extended product warranty) for a period of 15 years.

(2) All cabling components of the installed systems will meet or exceed the specification of TIA/EIA 568 B and ISO/IEC 11801 (performance warranty) for a period of 15 years.

(3) All shielded and unshielded twisted pair cabling links/channels will meet or exceed the attenuation and NEXT requirements of TIA/EIA TSB 67 and ISO.IEC 11801 (performance warranty) for a period of 15 years.

(4) All fiber links/channels shall meet or exceed the loss and bandwidth requirements of TIA/EIA TSB 67 and ISO/IEC 11801 (performance warranty) for a period of 15 years.

(5) The system shall be application independent and shall support both current and future applications that use the TIA/EIA 568 B or ISO/IEC 11801 component and link/channel specifications for cabling (application warranty) for a period of 15 years.

(6) All labor attributable to and required by the above supplied at no additional cost to the owner for a period of 15 years.

28.00.00 - ELECTRONIC SAFETY AND SECURITY

See the UA FRONT END DOCUMENTS (downloadable zip folder) for Owner-Provided SECTION 01 78 23 OPERATIONS AND MAINTENANCE DATA.

(1) The University has an IDIQ for electronic safety and security systems see attachment in this folder.

(2) Smoke detection shall be required in public spaces such as corridors, atriums and hallways and shall be spaced at no MORE than 30-foot intervals between devices.

(3) Remote fire alarm enunciators shall be placed at the main entrance to buildings OR as determined by Campus Fire Marshal.

(4) Fire alarm pull stations shall be required at every exit of the building, and in other hazardous locations as determined by the Campus Fire Marshal.

(5) When programming the fire alarm, it shall be programmed so that all tamper switches and flow switches can be disabled per floor or per area as determined by the Campus Fire Marshal.

28 31 00 COMBINATION MASS NOTIFICATION EMERGENCY COMMUNICATIONS AND FIRE ALARM SYSTEM

(A.) Description

(1) Revise this article to provide a functional description applicable to Project.
- (a) Signal priority shall be in accordance with UL 2572 as indicated below:
- (b) Special suppression (CO2, Halon, FM200, Intergen or similar total flooding gaseous suppression system)
- (c) Mass Notification
- (d) Life Safe/Fire Alarm
- (e) Other

(2) MNEC operation shall be initiated only from the CCS or respective building ACU/FACP or Local Operations Console (LOC). No automatic operation shall be permitted.
- (a) Any operation of MNEC at the building ACU/FACP or LOC shall be indicated at the CCS.
- (b) Any operation of the MNEC from the CCS shall indicate at the ACU/FACP & LOC (if provided) that the respective building system is in MNEC mode.
- (c) Provide all indicators required by UL 2572 and AHJ.
- (d) System operation shall be as specified in UL 2572.

(3) Pre-recorded messages shall be selectable at the CCS and respective building ACU/FACP or LOC and shall consist of a minimum of the following:
- (a) Lockdown
- (b) Weather warning
- (c) All Clear
- (d) Evacuation

(e) Stand by
(f) Chemical emergency
(g) Test

(4) The system shall be capable of live voice page from the CCS to each respective building. Live voice paging inside the respective building shall be capable of being initiated from the ACU/FACP or LOC

(5) Fire-alarm signal initiation shall be by one or more of the following devices:
(a) Retain only those devices and systems in subparagraphs below that are applicable to Project. Coordinate with requirements in other Sections that specify listed devices and systems.
(b) Manual stations.
(c) Heat detectors.
(d) Flame detectors.
(e) Retain one or both of first two subparagraphs below. Coordinate with Drawings if retaining both.
(f) Smoke detectors.
(g) Duct smoke detectors.
(h) Verified automatic alarm operation of smoke detectors.
(i) Automatic sprinkler system water flow.
(j) Heat detectors in elevator shaft and pit.
(k) Fire-extinguishing system operation.
(l) Fire standpipe system.

(2) Fire-alarm signal shall initiate the following actions:
(a) Retain only those actions in subparagraphs below that are applicable to Project. Coordinate with requirements in other Sections that specify listed devices and systems.
(b) Activate multiple channel pre-recorded voice messages followed by temporal tone.
(c) Continuously operate the visual notification appliances.
(d) Identify alarm at fire-alarm control unit and remote annunciators.
(e) Transmit an alarm signal to the remote alarm receiving station.
(f) Unlock electric door locks in designated egress paths.
(g) Release fire and smoke doors held open by magnetic door holders.
(h) Switch heating, ventilating, and air-conditioning equipment controls to fire alarm mode.
(i) Activate stairwell and elevator-shaft pressurization systems.
(j) Close smoke dampers in air ducts of designated air-conditioning duct systems.
(k) Coordinate first subparagraph below with "Elevator Recall" Paragraph in "Fire-Alarm Control Unit" Article.
(l) Recall elevators to primary or alternate recall floors.

(m) If supplies are not essential to life safety, retain first subparagraph below for shutoffs installed in supplies that may be hazardous.
(n) Activate emergency shutoffs for gas and fuel supplies.
(o) Record events in the system memory.
(p) Record events by the system printer.

(3) Supervisory signal initiation shall be by one or more of the following devices and actions:
(a) Retain only those devices and actions in subparagraphs below that are applicable to Project. Coordinate with requirements in other Sections that specify listed devices and systems.
(b) Valve supervisory switch.
(c) Low-air-pressure switch of a dry-pipe sprinkler system.
(d) Elevator shunt-trip supervision.

(4) System trouble signal initiation shall be by one or more of the following devices and actions:
(a) Retain only those devices and actions in subparagraphs below that are applicable to Project. Coordinate with requirements in other Sections that specify listed devices and systems.
(b) Open circuits, shorts, and grounds in designated circuits.
(c) Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
(d) Loss of primary power at fire-alarm control unit.
(e) Ground or a single break in fire-alarm control unit internal circuits.
(f) Abnormal ac voltage at fire-alarm control unit.
(g) Break in standby battery circuitry.
(h) Failure of battery charging circuitry
(i) High or low battery charge.
(j) Abnormal position of any switch at fire-alarm control unit or annunciator.
(k) Fire-pump power failure, including a dead-phase or phase-reversal condition.
(l) Low-air-pressure switch operation on a dry-pipe or pre-action sprinkler system.

(5) System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire-alarm control unit and remote annunciators. Record the event on system printer.

(B.) Global Event Graphical Workstation

(1) Provide Global Event Graphical Workstation (GEGW) where indicated on the project drawings that shall communicate with the fire alarm network(s) via supervised IP communications protocol with full command and control capability. The GEGW shall be password protected to operate common control functions from the Workstation including acknowledging, silencing, and resetting of fire alarm functions as well as

manually activating, deactivating, enabling and disabling of individual system points while maintaining UL 864 listing. The workstation shall be capable of generating status, maintenance and sensitivity reports. The workstation must be capable upon receipt of any event to activate an audio WAV file over the workstation speakers alerting the operator to an event, and providing audible instructions. The computer shall operate using Windows XP, SP3. Any other operating systems are not acceptable.

(2) The GEGW shall support a minimum of 80 Networks Systems via Ethernet using IP protocol communications. In addition the GEGW shall be able to support Digital Alarm Receiver unit that will monitor systems using Contact ID format via phone lines or Ethernet. The GEGW shall have the ability to create multiple commands between Networks to operate any sequence of operation.

(3) The GEGW shall have a paging microphone to selectively communicate to any building network or level within a building network or multiple selective combination or All Call. This voice paging shall be accomplished by Voice over IP communications to each network.

(a) Graphical screens shall be provided to select the manual paging virtual switch panel.

(b) Separate console is an option with sector switches, in lieu of virtual switches on the PC computer. Verify project requirements.

(c) Provide separate console with paging microphone and manual audio selector switches. Audio paging shall be accomplished by Voice over IP protocol to each network system.

(4) The GEGW shall have a Layout Manager to manage and configure the different screen (window) layouts for the operator System Control to be display simultaneously on the screen. Each of the windows can reside in any area on the screen. Layouts can also be assigned to access groups so that they load when a user from that access group logs in. A different layout can be assigned to every access group. The screen shall have dedicated areas for the following functions:

(a) Event List Display: All events shall be display in the order of priority, each event is color-coded by its type. The event type, description, location, date and time and count information is displayed for each event in columns on each tab. New events are displayed by priority and remain until they are acknowledged. Once the event is acknowledged, it moves into the Acknowledged Events list. The All Events tab displays all of the events that have taken place in your system, up to a maximum of 10,000 events.

(b) Red – Mass Notification or Alarms.

(c) Gold – Supervisory.

(d) Yellow – Trouble, Monitor, Non-Security, or Security By-Pass.

(e) Orange – Security Alarm.

(f) Grey – Disabled or Security Partition Armed.

(g) Green – Restored to normal.

(h) Workstation Display Filter: The GEWS shall be able to be configurable to filter events that would be displayed or not displayed at the workstation. Shall be able to select between; Alarms, Supervisory, Monitor, Troubles and Security events to be viewed

Examples are:

(i.) Telecommunications Workstation – View only Alarm events.

(ii.) Security Workstation – View only Alarm and Supervisory events.

(iii.) Maintenance Workstation – View all events.

(C.) Remote Client Software– Text Based

(1) It shall be possible via a compatible remote PC connection through an accessible connection to a VPN, LAN, or WAN to obtain status, diagnostics, and reports from the GEGW. The GEGW shall act as a server to simultaneously communicate the status of all systems connected to the graphics work station to up to five (5) concurrent remote PCs running graphics client software over the owner's data network or VPN. Clint software shall actively poll the graphic work station server to determine event status. All event changes shall be automatically announced on the client PC. No operator interaction shall be required to retrieve or display incoming events. Web browser technology shall not be considered as equal. All workstation to client communications shall be encrypted for privacy. It shall be possible to capture at the remote PC events that take place on the workstation. It shall be possible from the remote PC to run workstation and panel reports

(2) Shall be GE-EST, model FW-1S or FW-4S.

(D.) System Event Printer

(1) Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.

(2) Each control panel (network node) shall be capable of supporting a printer. All control panel printer ports shall be configurable to output any combination of alarm, supervisory, trouble, monitor, or group event messages.

(3) Printer shall be EST, model PT-1S/P.

(E.) GRAPHICAL MAP and REPORTS LASER PRINTER

(1) Provide a Color Laser printer connected to the GEGW that will print the graphical floor plan views and system reports. The printer shall be Hewlett Packard Color Laser printer

that supports PCL (Printer Control Language) and dual paper size shall be 8-1/2 x 11 & 11 x17.

(F.) IP CAMPUS NETWORK

(1) Provide dedicated Emergency Communications Ethernet IP Network. The IP Network shall be Multi-Mode (62.5/125 micron only) fiber optic cable. The TCP/IP network switches shall be industrial grade auto-negotiating switching hubs. Switch shall be UL864 listed, shall provide four (4)10/100 Mbps shielded RJ-45 connectors for twisted pair (Ethernet) connections and two 100 Mbps multi-mode fiber ports. The switches shall operate on a nominal 24 VDC supplied from a battery backed up fire alarm control panel or booster power supply to insure power to the switch is always available. Switches shall provide LED indicators for data rate, activity/link integrity, power and loop detection.

(2) Shall be EST, model MN-NETSW1.

(3) Each fire alarm control panel to LAN/WAN network interface shall be an industrial grade 10/100BASE T Ethernet® device server. The interface shall have diagnostic LEDs on the front of the unit make it easy to determine its status, and incorporate flash ROM memory facilitating upgrading the operating firmware. Power shall be supplied directly from the FACP, ensuring a reliable and monitored power source.

(a) Shall be EST, model MN-COM1S.

(4) The CCS control panel audio source shall be connected to the LAN/WAN network. The interface shall be Network audio connectivity and shall consist of a supervised encoder capable of encoding MP3, WMA, G.711 and PCM data streams in either HTTP, UDP or RTP format. Audio encoder shall operate on filtered-regulated 24 VDC power derived from the panel power supply. Power shall be supplied directly from the FACP or listed Auxiliary Power Supply, ensuring a reliable and monitored power source.

(5) Audio encoder shall be equipped with:

(a) A RCA jack line-level audio input.
(b) RJ45 10/100BASE T Mbit Automatic Ethernet port.
(c) RS232 DB9 male interface capable of 115,200 baud communication.
(d) Normally open relay contact rated at 500 mA @ 24 VDC.
(e) Reset button.
(f) Aluminum case.
(g) Audio from dedicated driver amplifier shall be stepped down from 25 VAC to 1 VAC by an MN-ABPM audio bridge.
(h) Shall be EST model MN-FVPN

(6) Each ACU/FACP control panel audio source shall be connected to the LAN/WAN network interface. Each Network audio connectivity shall consist of a supervised decoder capable of decoding MP3, WMA, G.711 and PCM data streams in either HTTP, UDP or RTP format. Audio decoder shall operate on filtered-regulated 24 VDC power

derived from the panel power supply. Power shall supplied directly from the FACP or listed Auxiliary Power Supply, ensuring a reliable and monitored power source.

(7) Audio decoder shall be equipped with:

(a) A RCA jack line-level audio output.

(i) RJ45 10/100BASE T Mbit Automatic Ethernet port.

(j) RS232 DB9 male interface capable of 115,200 baud communication.

(k) Normally open relay contact rated at 500 mA @ 24 VDC.

(l) Reset button.

(m) Aluminum case.

(n) Analog audio from the decoder shall connect to the ACU/FACP audio source unit, then to a MN-PASM supervisory module that is monitored by a SIGA-RM1 supervisory module.

(o) Shall be EST model MN-FVPN

(G.) Fire-Alarm Control Unit

(1) The main control panel or remote control panel(s) shall be a multi-processor based networked system designed specifically for detection, and one-way emergency audio communications applications. The control panel(s) shall be listed and approved for the application under the standard(s) as listed. The control panel shall be model EST3.

(2) The control panel(s) shall include all required hardware, software and site-specific system programming to provide a complete and operational system. The control panel(s) shall be designed such that interactions between any applications can be configured, and modified using software provided by a single supplier. The control panel operational priority shall assure that life safety takes precedence among the activities coordinated by the control panel.

(3) The network of control panels shall include the following features.

(a) Ability to download all network applications and firmware from the configuration computer on the network or at any control panel (network node) location.

(b) Each control panel (network node) shall have an LCD display with common controls. The display shall be configurable to display the status of any and all combinations of alarm, supervisory, trouble, monitor, or group event messages.

(c) Each LCD display on the system shall be capable of being programmed for control functions of any node or the entire network. The LCD display shall reside on the network as a node and continue to operate with a or with multiple faults fault on the network. An LCD can be programmed to be only operational when a node is operational in stand-alone mode, with a network fault.

(d) The system program shall have a minimum of 100 system definable Service Groups to facilitate the testing of installed system based on the physical layout of the system. Service groups that disable entire circuits serving multiple floors or fire zones shall not be considered as equal.

(e) Advanced Windows based programming with Program Version Reporting to document any and all changes made during system start-up or system commissioning. Time and date stamps of all modifications made to the program must be included to allow full retention of all previous program version data. The operator display shall clearly identify unacknowledged and acknowledged alarm, supervisory, trouble, and monitor status messages. The system shall provide the ability to download data from the analog/addressable detectors to a PC while the system is on-line and operational in the protected premises. The downloaded data may then be analyzed in a diagnostic program supplied by the system manufacturer.

(f) Provide system reports that list a detailed description of the status of system parameters for corrective action or for preventive maintenance. Reports shall be displayed on the operator interface or be capable of being sent to a printer.

(g) Provide an authorized operator with the ability to operate or modify system functions such as system time, date, passwords, holiday dates, restart the system and clear the control panel event history file.

(h) Provide an authorized operator the ability to perform test functions within the installed system.

(i) Supervision of system components, wiring, initiating devices and software shall be provided by the control panel. Failure or fault of system component or wiring shall be indicated by type and location on the LCD display. Software and processor operation shall be independently monitored for failure. The system shall provide fail-safe operation, with multiple-levels of system operation

(4) Each network control panel shall be capable of:

(a) Supporting up to 2500 intelligent analog/addressable points.

(b) Supporting up to ten (10) intelligent addressable loops, each loop supporting 125 detectors and 125 modules, total of 250 points per loop.

(c) Supporting network connections up to 63 other control panels and annunciators.

(d) Supporting up to 124 (security/access control) Keypad/Displays.

(e) Support up ten network digital dialers with Contact ID or SIA format and TAP Pager protocol.

(f) Supporting multiple RS-232 communication ports and protocol.

(g) Supporting up to 1000 chronological history events.

(h) Total network response shall not exceed 3 seconds

(5) Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, monitor, trouble and component status messages and control menu.

(a) The common control switches and with corresponding LEDs provided as minimum will be; Reset, Alarm Silence, Panel Silence, and Drill. It shall be able possible to add additional switches/LEDs as required.

(b) The main control panel shall have a display that is a 24 lines by 40 character graphic LCD and backlit when active.

(c) Each point shall have a custom event message of up to 40 charters, for a total of 80 characters. In addition instructional text messages shall be supported with a maximum of 2,000 characters each.

(d) Provide 8 simultaneous events to be displayed. The first seven (7) highest priority events in addition to the most recent event. The events shall be automatically placed in event types (Alarm, Supervisory, Monitor & Trouble) for easy access and it shall be possible to view the specific event type separately. Having to scroll through a mixed list of event types is not acceptable.

(e) Provide an internal audible signal with different programmable patterns to distinguish between alarm, supervisory, trouble and monitor conditions.

(f) This display shall be an EST 3-LCDXL1.

(g) Systems not capable of such a display on the main panel faceplate shall include a CRT/Monitor display meeting the above requirements and battery stand-by.

(6) Audio One-Way Voice Communications

(a) The voice communication system shall be eight (8) channel audio evacuation system, to allow the ability to have eight simultaneous announcements/paging. The audio channels shall be designed as such:

(i.) Mass Notification Message (HIGHEST PRIORITY)
(ii.) Fire Message
(iii.) Alert Message
(iv.) Stand-by Message
(v.) Elevator Message
(vi.) Stairwell Message
(vii.) Security/Weather Threat
(viii.) Manual Paging

(b) The system custom digital voice message shall provide a minimum of 100 minutes and be created as a .wav file format. All messages shall be able to be created on-site without any special tools or burning of chips. Provide as a minimum one twenty (20) watt supervised audio amplifier per paging zone. The system software shall be capable of selecting the required audio source signal for amplification. To enhance system survivability, each audio amplifier shall automatically provide an internally generated local 3-3-3, 1000 Hz temporal pattern output upon loss of the audio signal from the one-way emergency audio control unit, during an alarm condition.

(c) Audio amplifiers shall be power limited and protected from short circuits conditions on the audio circuit wiring. Each amplifier output shall be a supervised, dedicated, selectable 25/70 Vrms output.

(d) Provide a standby audio amplifier per node that will automatically sense the failure of any primary amplifier installed in the same panel and replace the function of the failed amplifier.

(7) Provide an Emergency Voice Communication System with the following design features:

(a) An audio control unit with Microphone for Paging.

(b) Provide 3-position switch for each evacuation signaling zone and "All-Call", with "Page FIRE", "Auto" and "Page ALERT" positions identified and two LED status indicators for each audio visual evacuation signaling "zone", one red and one yellow.

(c) These LED's shall illuminate to indicate respectively:

(i.) Evacuation signals activated (red),

(ii.) Trouble in audio (speaker) or visual (strobe) circuit(s) (yellow).

(8) Provide 2-position switch for manually activate pre-recorded voice messages, with "Message Name" positions identified and one LED status indicators, one red. Provide minimum of 12 selector switches.

(a) These LED's shall illuminate to indicate respectively:

(i.) Message activated (red)

(9) Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions

(10) Verify project circuit wiring requirements.

(a) Circuits Requirements:

(b) Signaling Line Circuits for Network Communications:

(i.) Class B, Style 7.

(c) Dedicated Ethernet IP Network shall be Class B.

(d) Signaling Line Circuits for Intelligent Analog Addressable Loop:

(i.) Class B, Style 4.

(e) No more than 100 detectors or 100 modules installed on a loop.

(f) Initiating Device Circuit:

(i.) Class B, Style B

(g) Notification Appliance Circuits:

(i.) Class B, Style Y.

(ii.) Maximum circuit loading to 2 amps for visuals.

(h) Activation of alarm notification appliances, smoke control, elevator recall and other functions shall occur within 3 seconds after the activation of an initiating device.

(11) Smoke-Alarm Verification:

(a) Initiate an audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.

(b) Activate an NRTL-listed and -approved "alarm-verification" sequence at fire-alarm control unit and detector.

(c) Record events by the system printer.

(d) Sound general alarm if the alarm is verified.

(e) Cancel fire-alarm control unit indication and system reset if the alarm is not verified.

(12) Elevator Recall:

(a) Smoke detectors at the following locations shall initiate automatic elevator recall. Alarm-initiating devices, except those listed, shall not start elevator recall.

(b) Elevator lobby detectors except the lobby detector on the designated floor.

(c) Smoke detector in elevator machine room.

(d) Smoke detectors in elevator hoistway.

(e) Elevator lobby detectors located on the designated recall floors shall be programmed to move the cars to the alternate recall floor.

(f) Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay.

(g) Water-flow switch associated with the sprinkler in the elevator pit may have a delay to allow elevators to move to the designated floor.

(13) Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke barrier walls shall be connected to fire-alarm system.

(14) Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change to alternate settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and print out the final adjusted values on system printer.

(15) Digital Alarm Communicator Transmitter: The system shall have an integrated off premise communications capability using a digital alarm communications transmitter (DACT) for sending system events to multiple central monitoring station (CMS) receivers. The system shall provide the CMS(s) with point identification of system events using 4/2, 3/1, Contact ID or SIA DCS protocols. The dialer shall have the capability to support up to 255 individual accounts and to send account information to eight (8) different receivers, each having a primary and secondary telephone access

number. System events shall be capable of being directed to one or more receivers depending on event type or location as specified by the system designed. In the event of a panel CPU failure during a fire alarm condition, the DACT degraded mode shall transmit a general fire alarm signal to the CMS.

(a) Digital data transmission shall include the following (Contact ID)
    (i.) Address of the alarm-initiating device.
    (ii.) Loss of ac supply or loss of power.
    (iii.) Low battery.
    (iv.) Abnormal test signal.
    (v.) Communication bus failure
(b) Shall be EST, model 3-MODCOM.

(16) Alpha-Numerical Pager Interface: The system shall transmit an alphanumeric system activity message, by event, by point descriptor to a commercial paging system of the owner's choice, using TAP Pager protocol.
(a) Shall be EST, model 3-MODCOM/P

(17) Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, shall be powered by nominal 24-V dc source.

(18) Secondary Power: Shall provide 24 hours supervisory and 15 minutes of alarm with batteries, automatic battery charger, and automatic transfer switch.

(H.) Remote Annunciator

Annunciator shall match those of fire-alarm control unit LCD display functions for alarm, supervisory, monitor and trouble indications and common system controls including; acknowledging, silencing, resetting, and testing. See section 2.3 E for specific requirements.

This display shall be EST, model 3-LCDXL1 or 3-LCDANN

(I.) NAC Power Supply:

The NAC power supply shall be independent unit that will provide power to visual strobe notification appliances. It shall be possible to configure the NAC's to follow the main panel's NAC or activate from intelligent synchronized modules. The booster NAC's must be configurable to operate independently at any one of the following rates: continuous synchronized, or 3-3-3 temporal. Fault conditions on the power supply shall not impede alarm activation of host NAC circuits or other power supplies. The NAC power supply must be able to provide concurrent power for notification devices, security devices, access control equipment and auxiliary devices such as door holders. All the NAC Power Supplies shall be synchronized. The power supply shall support up to 24 amp hour batteries.

(1) Power supply shall be minimum of 10 amps and UL 864 Listed.
(2) Four independent 3amp NAC circuits. Each being configurable as auxiliary power.
(3) All circuits shall be synchronized.

(4) Shall be EST, model BPS10A or APS10A

(J.) Intelligent Analog System Smoke Detectors

(1) Integral Microprocessor: All decisions are made at the detector determining if the device is in the alarm or trouble condition.

(1) Non-Volatile Memory: Permanently stores serial number, and type of device. Automatically updates historic information including hours of operation, last maintenance date, number of alarms and troubles, time of last alarm and analog signal patterns for each sensing element just before last alarm.

(2) Electronic Addressing: Permanently stores programmable system address. It shall be possible to address each intelligent module without the use of DIP or rotary switches. Devices using switches for addressing shall not be acceptable.

(3) Automatic Device Mapping: Each detector transmits wiring information regarding its location with respect to other devices on the circuit, creating an As-Built wiring diagram. This will also provide enhanced supervision of the device physical location and the device message shall reside with the location and not the device address. Devices installed in the wrong location will always report the correct message of the physical location.

(4) Sensitivity Range: Each analog addressable smoke detector's sensitivity shall be capable of being programmed individually as: most sensitive, more sensitive, normal, less sensitive or least sensitive. It shall be possible to automatically change the sensitivity of individual analog/addressable detectors for the day and night periods. It shall be possible to program control panel activity to each level.

(5) Pre-Alarm: Detector stores 20 pre-alarm sensitivity values to alert local personnel prior to the sensor reaching a full evacuation sensitivity. Sensitivity values can be set in 5% increments.

(6) Environmental Compensation: The detector's sensing element reference point shall automatically adjust, compensating for background environmental conditions such as dust, temperature, and pressure. Periodically, the sensing element real-time analog value shall be compared against its reference value. The detector shall provide a maintenance alert signal when the detector reaches 75% (Dirty) to 99% (More Dirty) compensation has been used. The detector shall provide a dirty fault signal when 100% or greater compensation has been used.

(7) Twin Status LEDs: Flashing Green LED shows normal; flashing RED shows alarm state; steady RED and steady GREEN show alarm state in stand-alone mode, visible from any direction.

(8) UL Sensitivity Testing: The detector shall utilize a supervised microprocessor that is capable of monitoring the sensitivity of the detector. If the detector sensitivity shifts outside of the UL limits, a trouble signal is sent to the panel.

(9) Device Replacement: The system shall allow for changing of detector types for service replacement purposes without the need to reprogram the system. The replacement detector type shall automatically continue to operate with the same programmed sensitivity levels and functions as the detector it replaced. System shall display an off-normal condition until the proper detector type has been installed or a change in the application program profile has been made. Select what type of smoke detector should be used for the project; 4D or 3D or Photo.

(K.) Intelligent 4D Multi-sensor Detector (Photo/Ion/Thermal and Time)

(1) Provide intelligent analog addressable 4D multi-sensor smoke detectors or equivalent at the locations shown on the drawings. The detectors shall gather analog information from each of its three fire sensing elements, photo, ion and temperature and convert these into digital signals. The signals shall be monitored and analyzed separately with respect to a fourth element – Time. Historical readings shall be compare against time patterns and known fire characteristics to make an alarm decision. Digital filters shall remove signal patterns that are not typical of fires.

(2) Separately mounted combinations of photoelectric detectors, ionization detectors and heat detectors in the same location, clustered at the manufacturer's listed spacing is an acceptable alternative.

(3) Provide EST, model SIGA2.

(L.) Intelligent 3D Multi-sensor Detector (Photo/Thermal and Time)

(1) Provide intelligent analog addressable 3D multi-sensor smoke detectors at the locations shown on the drawings. The 3D Intelligent detector gathers analog information from each of its two fire sensing elements and converts it into digital signals. The detectors on-board microprocessor measures and analyzes these signals separately with respect to a third element – Time. It compares the information to historical readings, time patterns and known fire characteristics to make an alarm decision. Digital filters remove signal patterns that are not typical of fires.

(2) Provide EST, model SIGA2-PHS.

(M.) Intelligent Photoelectric Detector

Provide EST, model SIGA2-PS.

(N.) Intelligent 135 Degree Fixed Temperature / Rate of Rise Heat Detector

(1) Provide intelligent combination fixed temperature/rate-of-rise heat detectors at the locations shown on the drawings. The heat detector shall have a low mass thermistor heat sensor and operate at a fixed temperature and at a temperature rate-of-rise. It shall continually monitor the temperature of the air in its surroundings to minimize thermal lag to the time required to process an alarm. The integral microprocessor shall determine if an alarm condition exists and initiate an alarm based on the analysis of

the data. Systems using central intelligence for alarm decisions shall not be acceptable. The intelligent heat detector shall have a nominal fixed temperature alarm point rating of 135oF (57oC) and a rate-of-rise alarm point of 15oF (9oC) per minute. The heat detector shall be rated for ceiling installation at a minimum of 70 ft (21.3m) centers and be suitable for wall mount applications.

(2) Provide EST, model SIGA2-HRS.

(O.) Fixed Temperature Heat Detector

(1) Provide intelligent fixed temperature heat detectors at the locations shown on the drawings. The heat detector shall have a low mass thermistor heat sensor and operate at a fixed temperature. It shall continually monitor the temperature of the air in its surroundings to minimize thermal lag to the time required to process an alarm. The integral microprocessor shall determine if an alarm condition exists and initiate an alarm based on the analysis of the data. Systems using central intelligence for alarm decisions shall not be acceptable. The heat detector shall have a nominal alarm point rating of 135oF (57oC). The heat detector shall be rated for ceiling installation at a minimum of 70 ft (21.3m) centers and be suitable for wall mount applications.

(2) Provide EST, model SIGA2-HFS.

(P.) Detector Base Types

(1) Provide standard detector mounting bases suitable for mounting on 1-gang, or 4" octagon box and 4" square box. The base shall, contain no electronics and support all series detector types. Bases with electronics or dip-switches are not acceptable.

(a) Provide EST, model SIGA2-SB or SB4.

(2) Provide relay detector mounting bases suitable for mounting on 1-gang, or 4" octagon box and 4" square box. The relay base shall support all Signature Series detector types and have the following minimum requirements:

(a) The relay shall be a bi-stable type and selectable for normally open or normally closed operation.

(b) The position of the contact shall be supervised.

(c) The relay shall automatically de-energize when a detector is removed.

(d) The operation of the relay base shall be controlled by its respective detector processor or under program control as required by the application. Detector relays not capable of operational programming independent of the detector shall not be considered equal. Form "C" Relay contacts shall have a minimum rating of 1 amp @ 30 Vdc and be listed for "pilot duty".

(e) Removal of the respective detector shall not affect communications with other detectors.

(f) Provide ST, model SIGA2-RB or RB4

(3) Provide audible detector mounting bases suitable for mounting on 4" x 4" octagonal concrete ring (mud box) and 4" square x 2-1/8" (54 mm) deep box.

(a) The base shall support all Signature Series detector types and be capable of single or group operation. The audible base shall emit a temporal alarm tone and be selectable for low or high output.

(b) The operation of the audible base shall be controlled by its respective detector processor or under program control as required by the application. Detector audible base not capable of operational programming independent of the detector shall not be considered equal.

(c) The audible bases shall be UL268 and UL464 Listed, and provide a reverberant room sound output per UL464 of 81 dBA at 10ft (3m). and an average anechoic sound output of 90 dBA at 10 ft.(3m).

(d) Provide EST, model SIGA2-AB4G.

(Q.) Intelligent Duct Smoke Detector – Photoelectric

(1) Duct smoke detectors shall not be used in association with fire/smoke dampers, air handling units, or fan coil units without approval from the Fire Marshall.

(2) Control of these devices shall be through the fire alarm control panel.

(3) Upon detection of smoke at an area smoke detector the fire alarm control panel shall shut down equipment.

(R.) Beam Smoke Detectors

(1) Provide reflective beam type smoke detectors at the locations shown on the drawings. This detector shall consist of a integrated transmitter and receiver capable of being powered separately or together.

(2) The detector shall operate in either a short range of 15 to 160 ft. or a long range of 160 to 330 ft. The detector shall feature a bank of alignment LEDs on both the receiver and transmitter to ensure proper alignment without the use of special tools.

(3) The detector shall utilize an automatic gain control to compensate for gradual signal deterioration from dirt accumulation on lenses. The beam smoke detectors shall be powered from the system control panel. Testing shall be carried out using calibrated test filters.

(4) Provide a remote key activated remote test station.

(a) Provide GE Beam Smoke Detector, model EC-50R or EC-100R with EC-LLT Test Station.

(S.) Intelligent Modules

(1) It shall be possible to address each intelligent module without the use of DIP or rotary switches. Devices using switches for addressing shall not be acceptable. The personality of multifunction modules shall be programmable at site to suit conditions

and may be changed at any time using a personality code downloaded from the Analog Loop Controller.

(a) Integral Microprocessor: All decisions are made at the module determining if the device is alarm or trouble condition.

(b) Non-Volatile Memory: Permanently stores serial number, and type of device. Automatically updates historic information including hours of operation, number of alarms and troubles, time of last alarm.

(c) Automatic Device Mapping: Each detector transmits wiring information regarding its location with respect to other devices on the circuit, creating an As-Built wiring diagram. This will also provide enhanced supervision of the device physical location. The device message shall reside with the location and not the device address. Devices installed in the wrong location will always report the correct message of the physical location.

(d) Twin Status LEDs: The modules shall have a minimum of 2 diagnostic LEDs mounted behind a finished cover plate. A green LED shall flash to confirm communication with the loop controller. A red LED shall flash to display alarm status.

(e) Input and output circuit wiring shall be supervised for open and ground faults.

(f) Two styles of modules shall be available, those designed for gang box mounting, and where multiple modules are required in a single location, plug in modules shall be provided with a Universal Input/Output motherboard.

(2) Intelligent Input Module. The Input Module shall provide one or two supervised Class B input circuit capable of a minimum of 4 personalities, each with a distinct operation. The module shall be suitable for mounting on North American 2 ½" (64mm) deep 1-gang boxes and 1 ½" (38mm) deep 4" square boxes with 1-gang covers. The single input module shall support the following circuit types:

(a) Normally-Open Alarm Latching (Manual Stations, Heat Detectors, etc.)

(b) Normally-Open Alarm Delayed Latching (Waterflow Switches)

(c) Normally-Open Active Non-Latching (Monitor, Fans, Dampers, Doors, etc.)

(d) Normally-Open Active Latching (Supervisory, Tamper Switches)

Provide GE-EST model SIGA-CT1 or CT2 or SIGA-MCT2

(3) Intelligent Relay Module. Provide addressable control relay circuit modules shall provide one (1) form C dry relay contacts rated at 24Vdc @ 2 amps (pilot duty) to control external appliances or equipment. The position of the relay contact shall be confirmed by the system firmware. The module shall be suitable for mounting on North American 2 ½" (64mm) deep 1-gang boxes and 1 ½" (38mm) deep 4" square boxes with 1-gang covers.

Provide GE-EST, model SIGA-CR or SIGA-MCR.

(4) NAC Control Module: Provide intelligent NAC control module shall provide one (1) supervised Class B output circuit capable of a minimum of 2 personalities, each with a

distinct operation. The gang box -mounted version shall be suitable for mounting in North American 2 ½" (64mm) deep 2-gang boxes and 1 ½" (38mm) deep 4" square boxes with 2-gang covers, or European 100mm square boxes. The plug-In version shall plug into a universal multi-module motherboard. The NAC control module shall support the following operations:

(a) 24volt NAC circuit
(b) Audio notification circuit 25v or 70v
(c) Telephone Power Selector with Ring Tone (Firefighter's Telephone)
(d) Visual Synchronized Output to Genesis appliances or to NAC Power Supply.
(e) Provide GE-EST, model SIGA-CC1 or –CC1S or SIGA-MCC1 or MCC1S.

(T.) FA Elevator Interface Cabinet

(1) Provide red metal cabinet enclosure with word FIRE in white letters on the cover. Inside will be four intelligent relays (Primary Recall, Alternate Recall, Fire Hat and Shunt Trip), one monitor input (Shunt Trip AC Power Supervision) and 120vac relay (Shunt Trip AC Power Supv).
(2) Label all the relays and input modules for the function.
(3) Provide GE-EST, model MFC-A with SIGA-UIO6, -MCR, MCT2 and MR-101.

(U.) Manual Fire-Alarm Boxes

(1) General Requirements for Manual Fire-Alarm Boxes: Comply with UL38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
   (a) Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
   (b) The manual pull station will have an intelligent module integral of the unit.
   (c) Station Reset: key operated switch shall match the control panel key.
   (d) Manual pull stations that initiated an alarm condition by opening the unit are not acceptable.
   (e) Provide EST, model SIGA-278.
(2) Indoor Protective Shield: Factory-fabricated clear plastic enclosure. Hinged at the top to permit lifting for access to initiate alarm. Lifting the cover actuates an integral battery powered audible horn (when noted on the drawings) intended to discourage false-alarm operation.
   (a) Weatherproof manual pull station shall be provided of red metal construction with special weatherproof gasket metal red box.
   (b) Single-action operation.
   (c) Station Reset: key operated switch shall match the control panel key.

(d) The intelligent monitor module will be located within the building and not with the station

(e) Provide EST, model MPSR1.

(V.) Notification Appliances

All appliances shall be of the same manufacturer as the Fire Alarm Control Panel specified to insure compatibility between the appliances and the control panels, and to insure that the application of the appliances are done in accordance with the single manufacturers' instructions.

(W.) Notification Appliances – Visual (Fire – Evacuation)

(1) Provide wall or ceiling mounted clear lens strobes with red body and "FIRE" markings. Strobes shall provide a smooth light distribution pattern field selectable candela 15 cd, 30 cd, 75 cd, and 110 cd flash output rating, UL1971 listed with in-out screw terminals shall be provided for wiring. The strobe (15, 30, 75, 110) candela rating shall be view from the side window to verify the setting. All strobes shall be synchronization to within 10 milliseconds for an indefinite period shall not require the use of separately installed remote synch modules. The strobes shall mount to one-gang electrical box.

(a.) The device shall have plastic protective cover for during installation.

(b.) The actual candela setting on the visual shall be marked on the appliance.

(c.) Provide EST, model Genesis Series devices.

(X.) Notification Appliances – Visual (ALERT – Mass Notification)

(1) Provide wall or ceiling mounted amber colored lens strobe with white body and "ALERT" markings. Amber strobe shall provide a smooth light distribution pattern field selectable candela 15 cd, 30 cd, 75 cd, and 110 cd flash output rating UL1638 listed, with in-out screw terminals shall be provided for wiring. The strobe (A, B, C, D) candela rating shall be view from the side window to verify the setting. All strobes shall be synchronization to within 10 milliseconds for an indefinite period shall not require the use of separately installed remote synch modules. The strobes shall mount to electrical box

(a) Provide Amber Strobe adapter plate that will allow G4 Speaker-Strobe. The amber strobe shall be located directly below the Fire clear lens strobe.

(b) The device shall have plastic protective cover for use during installation.

(c) Provide EST, model Genesis G1A or G4E Strobe Expander Series appliances.

(Y.) Notification Appliance - 4" Cone Speaker

(1) Speakers shall have a 4" Mylar cone, paper cones shall not accept as equal. The rear of the speakers shall be completely sealed protecting the cone during and after installation. In and out screw terminals shall be provided for wiring. Speakers shall provide 1/4w, 1/2w, 1w, and 2w power taps for use with 70V systems. The actual

speaker wattage & strobe candela setting shall be viewable from the device window to verify the wattage setting, without removing the device. To make any changes to the speaker wattage will only require the removal of the cover plate.

(a) At the 2-watt setting, the speaker shall provide a 90 dBA sound output over a frequency range of 400-4000 Hz. as measured in reverberation room per UL-1480.
(b) Combination speaker strobes shall meet both sections of above.
(c) The device shall have plastic protective cover for use during installation.
(d) The actual wattage setting on the speaker shall be marked on the face of the appliance.
(e) Provide EST, model Genesis Series devices.

(Z.) Notification Appliance - Re-entrant Speakers

(1) Provide 4" red re-entrant speakers at loud ambient locations or for outdoor weatherproof installation. Weatherproof boxes shall be provided for outdoor mounting. Speakers shall provide 2w, 4w, 8w, and 15w power taps. The re-entrant speakers shall utilize a high-efficiency compression driver. Cone type drivers are not acceptable. At the 15-watt setting, the speaker shall provide a 102 dBA sound output over a frequency range of 400-4000 Hz. when measured in reverberation room per UL-1480.
   (a) Combination speaker strobes shall meet both sections of above.
   (b) Provide EST, model Genesis Series devices.

(AA.) Guards For Physical Protection

Provide welded mesh of size and shape for the manual pull stations, smoke detectors, notification appliances at location noted on the drawings.

(BB.) MAGNETIC DOOR HOLDERS

Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.

(1) Electromagnet: Requires no more than 3 W to develop 25-lbf holding force.
(2) Wall-Mounted Units: Flush mounted unless otherwise indicated.
(3) Rating: 120-V ac, 24-V ac or dc.
(4) Provide EST, model 1500 series or DH Series.

(CC.) INSPECTION BAR CODES

(1) Inspection bar codes shall be installed on all initiating devices, annunciators, control panels and power supplies.
(2) Inspection bar codes used by the system must utilize Code 3 of 9 or other approved format, and contain a minimum of eight (8) digits that comprise a unique serial identifier within the Web-based Reporting System. There shall be no duplication of

serial numbers. Serial number shall be printed below the bar code for identification purposes.

(3) Inspection bar codes shall be limited in size to no more than 2" (5cm) in width, and 3/8" (2 cm), in height and shall include a Mylar® or other protective coating to protect the bar code from fading due to sunlight or exposure.

(4) Inspection bar codes shall be installed on each device in such a manner as to require that scanning of the bar code take place no further than 12" from the device during inspection.

(DD.) WIRE AND CABLE

(1) Signaling Line Circuits – Network Data: Twisted pair, not less than No. 18 AWG or as recommended by the manufacturer.

(2) Signaling Line Circuits – Intelligent Loop: Non-Twisted pair, not less than No. 16 AWG or as recommended by the manufacturer.
   (a) Circuit Integrity Cable: Provide as required to meet NFPA or Local Code requirements.
   (b) CI Cable shall meet article 760, power limited fire alarm service.

(3) Notification Appliance Circuits –
   (a) Audio: Twisted pair, not less than No. 16 AWG or as recommended by the manufacturer.
   (b) Visual. Non-Twisted pair, not less than No. 12 AWG or as recommended by the manufacturer.

(4) 120 VAC circuits
   (a) Minimum 10 AWG for panel power circuits. Minimum 12 AWG for all other circuits.
   (b) Sharing of neutrals is prohibited. Each circuit shall have its own dedicated neutral conductor.

(5) Fiber Optic Cable
   (a) Only glass filament cable permitted. Plastic filament fiber optic cables are not acceptable.
   (b) 62.5/125 micron fiber optic cables

(6) ST connectors used at all equipment terminations

(EE.)Equipment Installation

(1) Comply with NFPA 72 and NEC Article 760.

(2) Any low-voltage copper wiring that leaves the protection of a building shall be provided with a system manufacturer specified UL 497B listed transient protection devices where the circuit leaves the building and where it enters the next building.

(3) Equipment Mounting: Install MNEC/FA control unit on finished floor with tops of cabinets not more than 72 inches above the finished floor.

(4) Smoke- or Heat-Detector Spacing:
   (a) Comply with NFPA72, "Smoke-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for smoke-detector spacing.
   (b) Comply with NFPA72, "Heat-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for heat-detector spacing.
   (c) Smooth ceiling spacing shall not exceed 30 feet.
   (d) Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A [**or Appendix B**] in NFPA 72.
   (e) HVAC: Locate detectors not closer than [**3 feet**] [**5 feet**] from air-supply diffuser or return-air opening.
   (f) Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture.

(5) Duct Smoke Detectors: Comply with NFPA72 and NFPA90A. Install sampling tubes so they extend the full width of duct.

(6) Heat Detectors in Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location.

(7) Single-Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.

(8) Wall-Mounted Notification Appliances: Install so entire appliance is between 80 and 96 inches above finished floor on the wall.

(9) MNEC/FA Control Units: Surface mounted, with tops of cabinets not more than 72 inches above the finished floor.

(10) LOC/Annunciator: Install with top of panel not more than 72 inches above the finished floor.

(11) The System Supplier shall schedule and present a minimum of 8 hours of documented formalized instruction for the building owner, detailing the proper operation of the installed System.

(12) The instruction shall be presented in an organized and professional manner by a person factory trained in the operation and maintenance of the equipment and who is also thoroughly familiar with the installation.

(13) The instruction shall cover the schedule of maintenance required by NFPA 72 and any additional maintenance recommended by the system manufacturer.

(14) Instruction shall be made available to the Local Municipal Fire Department if requested by the Local Authority Having Jurisdiction.

29.00.00 - RESERVED