

# 15 Mechanical

## GENERAL

Designers shall verify that all applicable portions of these standards are incorporated into the project's design, drawings, specifications and final construction. Requests for variances from these standards shall be submitted in writing to the DCM Project Manager, using the KU Standards Variance Request Form found in [Appendix A1.1](#), for review and written approval or rejection as indicated on the form.

## RELATED DOCUMENTS & REQUIREMENTS

Refer to the following for requirements that also apply to work of this section.

- Division 1 - General Requirements:** Refer to sections regarding construction testing and field quality control requirements.
  - Unless directed otherwise, the Owner shall separately contract for quality control testing during construction, not the Contractor. Verify with DCM for each project.
- Division 15 - Standards of Practice:** The University has adopted specific mechanical system construction practices that are referenced by the applicable AIA – Masterspec section and/or University Standards of Practice (SOP). The Designer shall use the following supplemental guidelines and standards of practice in development of project construction documents.
  - [Appendix A15.1](#), SOP - Building Automation Control Systems
  - [Appendix A15.2](#), SOP - Building Commissioning
- Division 16 - Electrical:** Review all sections of Division 16 for related work and systems that must be coordinated with provisions of Division 15.

## BASIC MECHANICAL MATERIALS AND METHODS - 15050

**General Project Description:** The Designer shall include as one section of the specifications, a lay description of the design, operating function, loads, capacities, tolerances, sequence(s) of operation, etc., of the mechanical systems designed for this project. The intention of this document is to give all parties including the Contractor's installation personnel and the University's maintenance personnel a reference document for each particular system design. Samples of such documentation can be obtained from the University.

- The Designer shall update this lay description at later stages of design and construction, if the systems' operation changes, and shall provide copies of updates to the building's commissioning agent, as well as to the DCM and DOAS engineering project managers.

**Building Aesthetics:** The Designer is responsible for ensuring that mechanical equipment or systems are not located outside the building, or at a minimum, are designed to blend in with the building structure. The University reserves the right to determine the location of all equipment located outside the building. The Designer shall ensure that fresh air intakes, exhaust grilles and any other component of the ventilation system match or blend in with the building architecture.

**Pipe Penetrations and Sleeves:** This work shall be coordinated with Division 7. Floor sleeves shall extend above the finished floor a minimum of 2-inches and shall be sealed watertight. New penetrations shall be fire-stopped. Sleeve material would be specified to suit the wall or floor type being penetrated.

**Prohibited Pipe Fitting Materials and Methods:** Due to University requirements for long system life and the need for uniformity and consistency of piping system installations, field fabricated pipe and tubing fittings of the type commonly referred to as “drilled” or “pulled” tees are not allowed.

**Equipment Bases:** Concrete bases, 3-1/2 inch minimum height, shall be provided under all floor mounted mechanical equipment. Base size and location shall be coordinated with the equipment specified and shall be shown on the architectural and structural drawings.

**Designing in Existing Facilities:** The Designer is expected to field-verify existing conditions so that construction conflicts are minimized. For remodeling projects, the University will provide openings in walls and ceilings where required and requested by the Designer to permit verification of existing piping, ductwork, and equipment. Lack of ready access to hidden conditions during design is not considered to be an acceptable justification for unidentified and unresolved construction conflicts in construction documents.

**Equipment and System Cleaning:** The specifications shall include the requirement of system cleaning. After hydrostatic tests and prior to the operating tests, equipment including and not necessarily limited to the chiller, cooling tower, boilers, heat exchangers and all piping shall be thoroughly cleaned. The initial system cleaning shall be with a solution of caustic soda, trisodium, or a University approved equal. After the solution has cleaned the system, the solution shall be drained and thoroughly flushed out with fresh water. After initial cleaning, the Owner's representative, or designee, shall sign and certify that the system has been thoroughly cleaned.

**Jobsite Fire Safety Precautions:** The Designer shall include in the specifications the following or a similar statement with regard to protective measures to be observed by the Contractor during brazing, sweating, or welding operations:

- All cutting, welding, brazing, or sweating operations carried on in the vicinity of, or accessible to, combustible material, shall be adequately protected to make certain that a spark or hot slag does not reach the combustible material and start a fire.

- ❑ When it is necessary to do cutting, welding, brazing, or sweating close to wood construction, in pipe shafts, or other locations where combustible materials can not be removed or adequately protected, employ fireproof blankets and proper fire extinguishers. A helper shall be stationed nearby to guard against sparks and fire.
- ❑ Whenever combustible material has been exposed to molten metal or hot slag from welding or cutting operations, or spatter from electric arc, a guard shall be kept at the place of the work for at least one hour after completion to make sure that smoldering fires have not been started.
- ❑ Whenever welding or cutting operations are carried on in a vertical pipe shaft or where floor openings exist, a fire guard shall be employed to examine all floors below point of welding or cutting operation. The fire guard shall be kept on duty for at least one hour after completion of work to guard against fires.
- ❑ Before any work involving cutting, welding, brazing, or sweating operations is started, consult with the Designer as to particular safety precautions to be employed on the work.”

**Building Service Interruptions:** The Designer shall include in the specifications the following or similar statement with regard to interruptions of any campus utilities:

- ❑ The contractor shall contact the KU Facilities Operations project manager (currently Mike Miller, 864-4770) at least one week prior any utility shutdown for relocation or tie-in.

**Underground Service Surveys:** Coordinate this work with Division 2. The Designer shall include in the specifications the following or similar statement with regard to surveys of any new or relocated campus underground utilities:

- ❑ The Contractor shall contact the Facilities Operations survey coordinator (Engineering Shop, 864-5620) with 48-hour minimum notice and allow KU to survey locations and elevations of all new and relocated utility lines prior to backfilling.

**Verifying Existing Conditions:** On remodeling projects, the Designer is responsible for the verification of the actual operating conditions of HVAC systems requiring changes due to the proposed remodeling. The Owner shall not provide any equipment or labor for this purpose.

## MECHANICAL IDENTIFICATION - 15075

**Identifying Devices and Labels:** Piping system markers shall be pressure-sensitive, adhesive vinyl complying with ASME 13.1. Ducting systems and access door markers shall be specified to be stenciled in a manner complying with ASME 13.1. The Masterspec requirements for color-coding and nomenclature shall be included in the text of this section.

## DUCT INSULATION – 15081

**Duct Insulation Designs: Thickness** of supply air duct and plenum insulation shall be selected to prevent condensation on the surface of insulation where ambient dew point temperatures may exist. The Designer is responsible for determining the lowest potential

supply air temperature whether the ducting is associated with a new or existing air system.

- ❑ Fresh air intake ducts shall be insulated with fiberglass board insulation or duct wrap two inches thick, mechanically fastened, and shall have finish suitable to the location and surrounding conditions. Fastenings shall not penetrate to the inside of ducts. Insulation pins shall be fastened to ductwork by welding.
- ❑ Insulated ducts in exposed areas shall be insulated with fiberglass board or duct wrap one inch thick with glass cloth or canvas jacket with vapor barrier. In concealed areas ducts shall be insulated with 2 inch thick fiberglass blanket, 3/4 pound density.
- ❑ Insulation shall be suitably framed at all access panels.
- ❑ Duct liner is generally prohibited, but may be used for sound absorption in critical areas only after consultation with University Design Manager.
- ❑ Installation shall meet latest edition of SMACNA.

#### **EQUIPMENT INSULATION – 15082**

**Applicability:** Section 15082 shall be included in construction specifications for projects involving field-applied insulation of mechanical equipment.

- ❑ Pieces of equipment with a surface temperature over 130 degrees F or with temperatures causing condensation insulation where ambient dew point temperatures may exist shall be insulated.
- ❑ Equipment condensate drain pans shall be insulated. Type and thickness of insulation shall be as specified for piping.
- ❑ Steam traps, hot water and condensate return pumps, and hot water expansion tanks shall not be insulated.
- ❑ Specify factory insulation of autoclaves and sterilizers.

**Insulating Valve Bodies and Piping Specialties:** Specify preformed, removable insulation, blankets, sections and jackets for valves and specialties on insulated piping systems. Types of fittings included are valves, slip joints and steam and condensate meters. Each removable cover shall have a close contour fit for appearance and proper thermal performance.

**Abatement of Asbestos Materials:** Use of asbestos insulating materials is prohibited. Campus-wide abatement of existing asbestos-containing insulation materials is being undertaken on a project-specific basis. Therefore, to document the extent of abatement and replacement accomplished during each project, new insulation shall be stenciled, per OSHA 29 CFR 1926.1101, to identify it as non-asbestos containing.

## PIPE INSULATION – 15083

**Insulating Drainage Piping Systems:** Where appropriate to the project, this section shall include the specification of insulation for roof drain bodies and rainwater conductors. Similarly, coil condensate drain piping routed through finished spaces shall be insulated.

**Pipe Insulation in Wet Areas:** Insulation in potentially wet and unburied installations shall be covered with 30 mil PVC Jacket. Jacket shall be sealed at all joints per manufacturer's recommendation.

## VALVES - 15100

**Equipment Isolation:** The specifications shall include isolation valves. All equipment must be installed with isolation valves for shutoff service. All systems such as potable water, heating systems, chilled water systems, etc. must have a minimum of one isolation valve per building level or as required by the University representative.

**Reference to Controls System Specifications for Valves with Control Operators:** The Designer shall identify that valves equipped with electric, electronic, and pneumatic operators for automatic throttling control are specified and scheduled in Section 15900 - HVAC Instrumentation and Controls within the specification documents.

## METERS AND GAUGES – 15122

**Utilities Systems Ownership:** The distribution systems for all major campus utilities, except natural gas, are owned and maintained by the University. The Designer shall edit this specification section to delete references to Utility-furnished products. For billing purposes, each utility distribution system originates at a central campus entry point where master metering is provided. Individual metering described in this specification section is intended for University maintenance and administrative purposes only.

- Utility meters with demand pulse or similar system connected for remote computer monitoring shall be supplied for each of the following: domestic water, cooling tower water, chilled water, steam or condensate return, and natural gas. Each major piece of equipment such as chillers, air handling units, cooling towers, boilers and compressors shall have run-time clocks installed and shall be connected for remote monitoring by computer to accomplish this function on a cumulative monthly log. Ammeters shall be supplied on chillers and similar equipment.
- Remote Data Gathering Capability. All utility meters shall be directly connected to the campus BACS network. Refer to [Appendix A15.1](#), SOP – Building Automation Control Systems for interface requirements.

## HYDRONIC PIPING – 15181

**Heating Water Piping Systems:** The Designer shall include the following considerations in preparation of designs that include heating water piping systems.

- Standard weight black steel pipe, ASTM A53 or A120 continuous weld and Type K copper up to two inches.
- Piping systems up to and including two inches in size shall be screwed construction with standard weight cast iron fittings or brazed copper.
- Larger systems shall be welded, 150# class weld neck, or slip-on flanges.

**Chilled and Condenser Water Piping Systems:** The Designer shall include the following considerations in preparation of designs that include chilled and condenser water piping systems.

- Chilled and condenser water piping systems shall be standard weight black steel pipe, ASTM A53 or A120 continuous weld. Condenser water piping may be schedule 40 PVC with solvent weld joints, where allowed by Plumbing Code.
- Victaulic couplings may be used for connecting equipment to the piping system.

**Specialties:** The Designer shall include the following considerations in preparation of designs that include hydronic piping systems specialties:

- Provide details showing valves, unions, and controls on all converter and expansion tank systems. Properly size relief valves for the system designed.
- Provide piping connection detail showing valves, unions, control valves, flow metering devices and gauges for all types of coils.
- Expansion tank and makeup: Specify expansion tanks with butyl rubber bladders, Taco Series CA or University approved equal. Connect the make-water line at the location of the expansion tank.
- Make up water line: with code approved backflow preventer to protect the domestic water supply.
- Heating coils shall be provided with an approved vacuum breaker and air vent.
- Service Valves: Provide supply and return mains and risers with isolation valves for service and valved and capped drains at low points to facilitate complete drainage of the hydronic system.
- Vent all high points of the system with air vents that will not permit air to enter the system under vacuum conditions.
- In order to minimize water hammering, make up water lines to steam generators shall have slow close solenoid valves.

**Water Treatment:** All HVAC closed-loop water systems shall have a chemical corrosion protection system, using a mixture of Dowtherm SR-1 and water. All recirculating water systems shall be chemically treated. The Designer shall specify the necessary equipment for

treatment and the initial cleaning and treatment of the system. Do not specify supply of chemicals for the first year. The University will take over treatment of the system at substantial completion.

## STEAM AND CONDENSATE PIPING – 15182

**Steam Supply and Return Piping Systems:** The Designer shall include the following considerations in preparation of designs that include steam and condensate piping systems.

- Steam distribution piping shall be black steel pipe; ASTM A120 welded through four inches; A53 welded for larger pipe.
- Condensate return piping shall be extra heavy steel pipe, ASTM A53 or A120, continuous welded.
- Steam and condensate piping shall be of welded construction, except at valves, traps, and similar devices. Exception: Low pressure (0-15 psig) steam and low pressure condensate return piping two inches and under may be screwed using extra heavy weight malleable or cast iron fittings.
- Piping larger than two inches in size shall be fabricated using butt or socket weld fittings. Flanges may be welded neck or slip-on type 150# class (through 75 psig) or 300# class (above 75 psig).
- Drip piping shall be welded except for connection to screwed strainers and traps. Screwed unions shall be 300# AAR, or black steel.
- Drip and trap assemblies for steam mains and headers shall be fabricated using two inch extra heavy steel nipples with screwed caps for mains over two inches line size, and line size for lines under two inches, with full size gate valve (N.O.) between the main and the take-off to the trap.
- Steam and return piping, valves fittings and accessories shall be accessible for maintenance.
- Traps shall not be bypassed. Traps shall be designed to have a test valve discharging to atmosphere located between the trap and the discharge shut off valve.
- Branch steam mains shall be valved at the main.
- Flanges or unions shall be provided, and valving arranged so removable equipment may be easily dismantled for maintenance without disruption of service.
- Flash Tank: High pressure condensate shall be discharged to a flash tank before draining to a low pressure condensate return line.
  - The flash tank shall be vented to the outside.
  - The Designer shall include a detail of the flash tank installation including piping arrangement.
  - The design of the flash tank installation and its sizing shall comply with all the requirements in the Minnesota High Pressure Steam Code. Utilize the flash steam to the greatest extent that is economically possible.

### LABORATORY AIR, GAS, AND VACUUM PIPING – 15212

- ❑ The specifications for plumbing work shall include providing all piping, sleeves, valves, stops, sink trim, laboratory bench and fume hood trim, sinks, and piping insulation required for the complete installation of mechanical services to laboratory benches, sinks, and fume hoods.
- ❑ The Designer will be responsible for coordinating the plumbing installation design with the laboratory furniture shop drawings. Provision shall be made in the drawings or in the specifications for minor location adjustments to meet the equipment requirements. These adjustments shall be made before the installation of the plumbing piping systems.
- ❑ Services such as hot or cold water, vacuum, and gas shall have a valve specified and shown on the drawings which will be easily accessible after installation of the equipment so that service to the unit may be shut off for maintenance or repair.

### CHEMICAL-WASTE PIPING – 15221

- ❑ The Designer shall consult with the University in each case where corrosive wastes are to be disposed of to determine the extent of corrosion resistant waste and vent stacks, horizontal runs, and ground runs required.
- ❑ Corrosive waste drain and vent systems shall be specified for all laboratories where use of acids or other corrosives is probable. In general, the design and specifications shall be based on borosilicate glass drain line piping with approved couplings. Glass drain lines may be installed underground providing such piping is completely encased in approved foam plastic envelopes prior to backfilling.
- ❑ Approved polypropylene or polyethylene waste and vent systems may be used in lieu of glass for horizontal runouts not exceeding 60 feet in developed length, subject to the following conditions:
  - ❑ All material furnished shall be fire retardant and self-extinguishing.
  - ❑ Plastic materials shall penetrate fire rated floors, walls, or partitions using U.L. listed penetrations and fire stop materials.
  - ❑ Requests for such system substitutions will be approved by the Designer upon receipt of certification by the Contractor and the system manufacturer that design conditions will not adversely affect the system when installed.
- ❑ All corrosive waste drain and vent systems shall be clearly shown by riser diagrams or equivalent means of identification, indicating by suitable symbols the exact extent of the acid resistant piping. Diagrams shall be complete enough to show exact terminal fittings.
- ❑ Where long runs of horizontal acid resistant waste piping are required for high temperature wastes, install expansion joints to relieve stress on joints caused by expansion and contraction. Indicate where expansion joints are to be located in the system.
- ❑ Where traps are installed, corrosion resistant tailpieces shall be used. Adequate space shall be provided for servicing traps.

- Provide a waste water sampling port at the lowest common collection point.

#### **WATER DISTRIBUTION PIPING – 15411**

- The domestic hot water piping system can be either designed as a recirculating loop or with point of use water heaters. The Designer shall provide Life Cycle Cost Analysis for systems with total design deliveries of greater than 500-gph. Water heaters serving non-looped systems must be within 25 feet of point of use.
- All exposed piping in toilet rooms shall be chrome plated.

**Backflow Prevention:** Comply with the University backflow prevention program. Copies are available from the Department of Facilities Operations.

- "Watts" is preferred as the base manufacturer for all backflow preventers.
- Reduced pressure principle backflow preventers shall be piped to "dump" into a floor drain of adequate size to handle full flow.

**Disinfection of Domestic Water Piping:** The specifications shall include the requirement that all water main systems are to be purged and disinfected by the Contractor, in accordance with AWWA C651 or 652.

**Special Laboratory Plumbing Requirements:** Where applicable, the Designer shall coordinate specification sections 12347 and 12348 for Laboratory casework, and section 15490 – Special Fixtures and Systems for special laboratory requirements.

- Laboratory sinks shall be epoxy resin, or University approved equal, to match laboratory counter tops.
- Laboratory sinks shall be complete with borosilicate glass or polypropylene tail pieces and traps.
- Emergency Eye Wash and Safety Shower Installation.

**Special Kitchen Plumbing Requirements:** Where applicable, the Designer shall coordinate specification sections 12320 Restaurant and Cafeteria.

- The specifications for plumbing work shall include providing all piping, sleeves, shutoff valves, and pipe insulation to kitchen equipment locations.
- Specifications shall require the piping to terminate at exact equipment locations in accordance with a shop drawing to be furnished by the kitchen Equipment Contractor.

#### **DRAINAGE AND VENT PIPING – 15420**

- Chloraloy or approved equal membrane flashing to extend 12-inches from the clamping ring on all floor drains located in slabs not on grade.

- ❑ The lowest floor in the building, whether basement or grade level, must have adequate floor drains to the sewer. There should be more than one floor drain on this lowest level.
- ❑ Every restroom must have a floor drain.
- ❑ Floor drains in machine rooms must be accessible and must not be located under equipment.
- ❑ Floor drains shall not be located in air handling units unless the drains go to an indirect waste outside the unit.
- ❑ Drain, waste and vent piping below grade shall be service weight cast iron with bell and spigot Tyseal fittings.
- ❑ Drain, waste and vent piping above grade shall be service weight cast iron with stainless steel no-hub couplings.

### MECHANICAL EQUIPMENT SOUND CONTROL – DESIGN GUIDELINES

**General:** The University has experienced numerous problems with excessively loud or annoying sounds and noise levels generated by mechanical equipment, such as chillers and cooling towers, which disrupt the activities of persons within university buildings or living in residential areas adjoining the University.

- ❑ Designers shall specify equipment and design the project so that generated sound levels do not exceed those established as acceptable for each project.
- ❑ Refer to **Division 1 – General Requirements section re: Acoustical Design Services**

**Noise Levels:** The University will establish acceptable noise generation and sound level criteria for each project, as appropriate for it's intended use and location. Unless established otherwise, the standard sound levels that may be generated by mechanical equipment and other equipment installed as part of any KU project shall not exceed the following levels, when measured on the receiving property.

- ❑ 7am to 11pm: 55 dba maximum
- ❑ 11pm to 7am: 50 dba maximum
- ❑ For any source of sound which emits a pure tone or impulsive sound, the maximum sound level limits indicated above shall be reduced by 5 dba.

**Point of Measurement:** For exterior equipment, those sound levels shall be measured either along the property line of adjacent privately-owned property, or at the face of adjacent University buildings. For interior equipment, it shall be measured within the adjacent occupied rooms.

- ❑ **Future Building Sites:** Sound shall also be controlled and measured along the assumed perimeter of future buildings. Future building sites shall include those indicated on the Campus Master Plan and those identified by University personnel during the preliminary design phases.

**Equipment:** The Designer shall specify acceptable noise levels to be met by the manufacturer of each type of equipment. Confirm with Owner's Representative the need for factory testing for verification of performance.

**Documentation:** The Designer shall provide calculations and other documentation as necessary to verify to the University's satisfaction that proposed design meets these criteria. The Designer shall document the following minimum considerations:

- Manufacturer's data that identifies unattenuated sound pressure levels for prospective machines at known directions and distances from the machine.
- Designers are to verify that this data represents sound levels resulting from both compressor and condenser fan operation, and that this data is based upon a compressor type that matches the compressor type in the proposed specifications.
- Designers are to verify if the proposed machine has different sound pressure characteristics for the sides and opposite ends of the unit.
- Calculations to convert the manufacturer's data from the sound levels at the distance from the machine indicated in their data, to the estimated sound pressure level at the adjacent buildings or property lines surrounding the project.

**Sound Attenuation Options:** If calculations and documentation indicate that proposed equipment will apparently exceed the allowable noise levels, Designers shall do one or more of the following, provided they are documented as providing effective sound control within the acceptable levels.

- Modify the specified equipment type, such as a different type of chiller
- Limit the manufacturers to those who can meet the acceptable criteria
- Specify sound control accessories to be provided with the equipment
- Provide architectural barriers or screen walls

#### **ABSORPTION CHILLERS – 15621**

**Prohibited Use:** Absorption Chillers shall NOT be specified.

#### **CENTRIFUGAL WATER CHILLERS – 15625**

**Approved Refrigerants:** The University is phasing out its use of CFC-based refrigerants.

- Designers shall specify machines built for operation with HCFC-123, HFC-134A refrigerants, or HCFC-22.

**Special Warranties:** The Designer shall specify minimum five-year factory warranties for all water chiller compressors. Shall include all parts, labor, and diagnostic labor. Shall include annual inspection for first five years.

**Selection Criteria:** The Designer shall use the following a general guidance in selection of chilled water system components.

- For systems smaller than 100 tons, the recommended system is a screw or scroll compressor chiller with an air-cooled condensing unit. For replacement chillers where an existing cooling tower is suitable for reuse, the new chiller may be designed as water-cooled.
- For cooling loads over 100 tons but less than 250 tons, water cooled screw compressor chiller or centrifugal compressor chiller shall be used.
- Over 250 tons, the Designer shall specify the use of water cooled centrifugal chillers.
- Heat rejection equipment shall be rated at 105 degrees ambient.
- Chilled water systems shall be selected with a minimum 12 degree delta T.
- Air-cooled chillers may use a remote evaporator for freeze-protection. Alternately, provide a glycol/water mixture with and circulating pumps for freeze protection. Heat tracing is not recommended.

**Year-Round Cooling:** Special year-round cooling and dehumidifying systems shall be stand-alone air conditioning units capable of operating at outside temperature of as low as minus-20 degrees F and shall be separated from the general comfort cooling system in the building. These special systems shall be equipped with an economizer cycle.

- Examples of these special cooling systems are research spaces, telecommunication rooms, computer rooms, dry rooms, and instrumentation rooms.
- When required by application, condensing equipment shall be capable of starting and operating at 0 degree ambient temperature.

**Refrigerant Emissions Safety Systems:** Equipment rooms with refrigeration equipment shall comply with ASHRAE Standard 15, with exception of self-contained breathing apparatus which will be provided by Owner.

- Chillers shall be equipped with high-efficiency refrigerant recovery/purge systems.

**Remote Monitoring:** The Designer shall specify that newly installed water chillers be capable of communicating with the University's Building Automated Controls System (BACS) network with integration.

- Refer to [Appendix A15.1](#), Standard of Practice - Building Automation Control System for additional discussion of the University's campus-wide BACS network.

## RECIPROCATING WATER CHILLERS – 15625

**Prohibited Use:** Air-cooled reciprocating chillers shall not be specified for systems greater than 10 tons. Condensing unit shall be rated at 115 degrees F. ambient.

## PACKAGED COOLING TOWERS – 15640

**Cooling Tower Specifications:** If it is determined that a cooling tower is necessary for the air conditioning system and other heat rejection systems, careful consideration shall be given to its location in relationship to: noise and appearance, prevention of fresh air intake contamination, disease spread, and similar aesthetic or environmental issues, as well as function. It is intended that landscape arrangements and appearance will be included in the discussions of other site considerations.

- All wetted, non-media surfaces of cooling towers and evaporative condensers shall be stainless steel. All cooling tower support beams (steel) shall be hot-dip galvanized to ASTM specifications.
- Cooling tower fans shall be gear-driven and supplied with synthetic oil for five year maintenance-free operation. If capacity control is required, use variable frequency drives on fan motors. Tower controls shall include flow bypass and fan speed reduction based upon measured return water temperature.
- Cooling towers shall not be located at lower elevation than chiller.

## ROTARY-SCREW CHILLERS – 15684

**Selection Criteria:** The Designer shall use the following as general guidance in selection of chilled water system components.

- For systems smaller than 100 tons, the recommended system is a screw or scroll compressor chiller with an air-cooled condensing unit. Condensing unit shall be rated at 115 degrees F. ambient.
- For replacement chillers where an existing cooling tower is suitable for reuse, the new chiller may be designed as water-cooled. For cooling loads over 100 tons but less than 250 tons, water cooled screw compressor chiller or centrifugal compressor chiller shall be used. Heat rejection equipment shall be rated at 105 degrees ambient.

## AIR TERMINALS – 15845

- Preferred source of reheat is hot water. Provide access panel upstream for cleaning.
- Steam reheat coils where required, shall be steam distribution type with sufficient pitch to completely clear the coil in the event of trap failure. No copper tubes.

### AIR-TO-AIR ENERGY RECOVERY UNITS – 15846

**Exhaust Air Energy Recovery:** Each 100-percent exhaust makeup air system that operates 24 hours per day and has a total outdoor air requirements exceeding 5,000 cfm shall include energy recovery hardware. This hardware shall be capable of recovering at least 50 percent of the potential cooling or heating effect of the exhaust air whenever the temperature difference between the exhaust and outside air exceeds 10 degrees F.

- Run-around coils shall be used in all instances except high latent loads, where desiccant wheels may be used.
- Heat recovery systems shall be controlled to prevent overheating. If other opportunities exist for heat recovery the Designer shall provide an energy cost analysis for the proposed system.

### FANS – 15850

**Fan Identification:** All fan units shall be permanently marked to clearly identify the area served.

- Provide ventilation for battery chargers in housekeeping closets.

### CENTRAL-STATION AIR-HANDLING UNITS – 15854

**Key Air Handling Unit Specifications:** Air handling units over 2000 cfm and all 100 percent outside air ventilating units shall have the following features:

- Double wall galvanized construction with perforated inner wall.
- Two inch wall thickness--typical
- Four inch wall thickness in sections where the air temperature is less than 0 degrees F
- Less than one percent leakage per section at operating conditions.
- All coils supported on stainless steel racks to allow individual removal of coils
- Stainless steel drain pan below each coil.
- The coil drain pans drainage system shall be designed to handle the maximum static pressure of the system. The water shall flow out of the pan at the specified maximum static pressure, without overflowing the pan.
- Air handling units shall have door access to filters, heating and cooling coils, dampers, humidifiers, and fan. The Designer shall include in the plans the manufacturer recommended clearances for maintenance and repair work. The contract documents shall show the service space around all equipment. Panels shall be gasketed and air tight.
- Fans shall not require shaft removal for bearing replacement.
- Vane axial fans above five inch static pressure shall have thrust restraints.
- Air handling units over 15000-cfm units shall be provided with interior service and

inspection lighting at each access door.

- Provide air handlers with a 35-percent efficient pre-filter and an 80-percent efficient final filter. Provide cartridge style filters. Efficiencies shall be based on ASHRE standard 52.
- The Designer shall specify a set of filters upstream from heat recovery coils.
- To maintain coil cleanliness, conserve energy and extend filter life, the selection of the filter area shall be based on a maximum face velocity in constant volume units of 350 FPM. In variable volume units the maximum design velocity at the filters shall be 500 fpm.
- Steam preheat coils are required for entering air temperature below 35 degrees F. Preheat coils shall be integral face and bypass coils, 150# W.S.P. construction; Wing, Flo-con, or University approved equal. No copper tubes.
- All heating coils shall be provided with an approved vacuum breaker and air vent.
- Chilled water coils shall be completely drainable through individual headers; Trane Type D or University approved equal. Specify EWT and LWT to the cooling coil to provide minimum 12 degree F. delta T. Chilled water coils shall be a maximum of eight rows and shall be selected for maximum 500 FPM face velocity.
- Hot water coils shall be completely drainable through individual headers. Specify EWT to the heating coil of 180 degrees F.
- Provide piping connection detail showing valves, unions, control valves, flow metering devices and gauges.
- Air handling units shall be of blow-thru configuration wherever possible. Where hot water heating coils are draw-thru, mixing vanes are required to prevent stratification.
- Specify factory service level off-site training for two Facilities Operations technicians.
- All new air handling units shall be directly connected to the campus BACS network. Refer to [Appendix A15.1](#), SOP – Building Automation Control Systems for interface requirements.

**Rooftop Air Conditioners:** When other viable options are not available, rooftop equipment may be considered.

- The Designer shall locate the unit to minimize the adverse effects to the building aesthetics.
- The Designer shall select unit and location to minimize noise impact on occupied spaces.

#### **FIBROUS-GLASS DUCTS – 15812**

**Prohibited Use:** Fibrous-glass duct material shall not be specified.

## METAL DUCTS – 15815

**Duct Drainage: Outside** air intake chambers shall be furnished with water tight drain pans two inches minimum depth. An indirect drain line shall be designed to carry rain or melting snow to a nearby floor drain.

- At duct humidifiers, solder ductwork water tight five feet upstream and 25 feet downstream of the ductwork. Pitch ductwork to a drain located at the humidifier. No duct or terminal box liner in section with humidifier.
- All ducts exposed to weather shall be watertight.

**Duct System Classifications and Testing:** The Designer shall determine static pressure ranges for each duct section in a system. Any sections expected to operate above 3.0-inches H<sub>2</sub>O of static pressure shall be identified as such on construction documents. The Designer shall specify and witness duct leakage tests on supply and exhaust systems expected to operate above 3.0-inches H<sub>2</sub>O of static pressure. The frequency and extent of testing to be determined by design engineer, and University.

**Building Penetrations for Air Intake and Exhaust:** The Designer shall coordinate size and type of louvers, roof intake and relief hoods. Each intake shall be sized based on manufacturers criteria for no rain and snow penetration or carry-over into the air handling system.

### Ductwork Construction Criteria:

- No pipe or any other type of obstruction shall pass through a duct.
- Contract documents shall indicate duct transitions. Duct transitions at fan discharges shall have a maximum slope of one in seven. Supply duct connections shall be made with a 30 degree to 45 degree take-offs in the direction of air flow. Tee connections shall be used only where necessary.
- Flexible duct length shall not exceed six feet. Limit total sag to less than 1/2 inch per foot. Minimize bends in flexible duct, limit total bends on one branch to 90 degrees.
- Firestopping sealants shall be installed in accordance with the requirements of Section 07270. Refer also to **Division One** of the KU Design Standards.
- The Designer shall coordinate the sealing of floor and wall penetrations.
- All ventilation ducts and related piping shall be independently supported from the building structure. All horizontal ducts 48 inches or wider shall be rigidly and securely supported with trapeze hangers formed of rods and angle iron under duct, according to SMACNA standards.
- All vertical ductwork shall be supported by structural members at each floor.
- Preferred insulation system is duct wrap or duct board.

**Criteria for Placement of Building Air Intakes:** It is the responsibility of the Designer to locate the outside air intake away from sources of exhaust fumes such as loading docks,

parking areas, heavily trafficked areas, cooling towers, incinerator stacks, fume hood stacks, and other stacks exhausting toxic or radioactive materials, nuisance odors, plumbing vents, emergency generator exhausts, and engine driven fire pumps exhausts.

- It is the responsibility of the Designer to locate building exhausts away from air intakes on adjacent existing buildings.

## **HVAC INSTRUMENTATION AND CONTROLS – 15900**

**Responsibilities for Design:** The Designer should be aware that the University has a contractual agreement with Johnson Controls, Inc. to provide all systems and equipment for installations of building automated controls systems campus-wide.

- The project Designer is responsible for development of an HVAC controls system design that meets the specific needs of the site and/or building location of the project.
- Johnson Controls, Inc., the University's controls system provider, has responsibility for provision and startup of a system that conforms to the Designer's requirements.

**Minimum Requirements for Design Documents:** The Designer is expected to provide the following documents as part of any HVAC design that includes DDC controls:

- Control Diagrams
- Description Of Operation and Sequence of Controls
- DDC Points Schedules
- Valve Schedules
- Damper Schedules

**Control Air Compressor and Dryer:** The Designer shall use the following guidelines in completing projects with control air compressor and/or dryer requirements:

- For remodeling projects, the Designer shall have the air source tested for oil contamination and dew point and determine the condition and capacity of the existing pneumatic temperature control system before connecting new controls to the system. At the point of connection, specify an air filter/regulating station that will include a coalescing oil/dirt filter, activated carbon filter, relief valve, isolation ball valves, and inlet and outlet pressure gauges.
- If a new air source is required, specify a refrigerated dryer, adequately sized duplex compressor, oil-dirt filter, activated carbon filter, automatic tank drain, and automatic alternator.
- Compressors (alternating, duplex) shall be sized to run a maximum of one-third of the time and shall have no more than 10 cycles per hour. The air dryer shall be sized for 100 percent compressor run time. Compressor sizing will be tested as a part of building commissioning.

## SEQUENCE OF OPERATION – 15940

The Designer shall supplement specifications with necessary mechanical equipment control diagrams to clearly define sequences of operation required and responsibilities of mechanical and electrical subcontractors.

**Energy Considerations:** The Designer shall use the following guidelines in completing projects with opportunities for energy conservation:

- Run Equipment Only When Needed:** Schedule HVAC unit operation for occupied periods. Run heating at night only to maintain internal temperature between 60 and 65 degrees F to prevent freezing.
  - Start morning warm-up as late as possible to achieve design internal temperature by occupancy time (optimal start control) taking into account residual temperature in space, outdoor temperature, and equipment capacity.
  - Do not use outdoor air for ventilation until the building is occupied, and then use psychometrically proper outdoor air quantities.
  - When on minimum outdoor air, do not use more than that recommended by applicable standards and codes.
- Sequence Heating and Cooling:** Do not supply both at the same time. Central fan systems shall use cool outdoor air in sequence between heating and cooling.
  - The zoning and system selection should eliminate or at least minimize simultaneous heating and cooling. The only exception to this would be for areas that require dehumidification.
- Provide Only the Heating or Cooling Actually Needed.** In general, the supply temperature of hot and cold air (or water) should be reset according to actual need. This is especially important on systems or zones that allow simultaneous heating and cooling.
- Supply Heating and Cooling from the Most Efficient Source:** Use free or low cost energy sources first, then use higher cost sources if necessary.
- All energy consuming systems shall have controls on them to optimize energy consumption.
- Electric heat or reheat is prohibited.

**Fume Hood Control:** Laboratory airflow control components shall be specified to be supplied by Johnson Controls, the Universities temperature control systems provider, using Phoenix Controls equipment.

- The temperature control contractor shall be responsible for all of the temperature controls and the laboratory airflow controls, thus creating a single source for responsibility.
- The energy management system shall be required to be furnished with interface panels, software and programming necessary to communicate with the laboratory airflow control DDC panels and also communicate this information back to the BACS System campus backbone for remote monitoring. The interface would be required to accomplish the

following:

- Receive all critical alarms.
- Monitor current conditions of all points
- Change set points.
- Trend critical data.
- Modifying point data (alarm limits, etc.)
- Override output points in emergency situations.
- The laboratory airflow control system shall be required to be a completely engineered, cataloged and factory coordinated by a single manufacturer; with the system installed by and set up by an authorized factory representative.

**Utilities Metering and Controls Interfaces:** The Designer shall review [Appendix A15.1](#), for a discussion of the University's use of BACS for remote monitoring and metering.

#### **TESTING, ADJUSTING, AND BALANCING SECTION - 15990**

**General Requirements:** The Designer should be aware that the University may elect to retain the services of an independent commissioning agent for projects that involve the installation of utilities systems.

- As early in the design phase of a project as is possible, the Designer shall determine, through discussion with the University, if the project team will include a commissioning agent.
- The Designer shall specify detailed testing, balancing, and adjusting procedures by an independent agency only if independent commissioning is not planned for the project.
- Refer to the [Appendix A15.2](#), Standard of Practice - Commissioning for a discussion of the project commissioning means, methods, and objectives.

#### **Systems Testing – Non-Commissioned Projects**

- Piping Systems Tests:** Detailed requirements for pipe system cleaning, flushing, disinfecting, and pressure and vacuum leakage testing should be included in the applicable specification sections.
- Ductwork Systems Testing:** Detailed requirements for duct system leakage testing shall be included in the applicable specifications sections for those duct systems whose pressure class warrants testing.
- Automatic Sprinkler System Testing:** Current NFPA test procedures shall be used for testing automatic sprinkler systems.
- Tests shall be required upon completion of controls installation to certify adequate compressor sizing and integrity of control air system.
- The temperature control contractor will be responsible to provide needed assistance to

the balancing contractor during the balancing of the HVAC systems.

- The balancing contractor shall be subcontracted through the general contractor, not the mechanical contractor.
- The balancing contractor shall be pre-qualified through the Division of Architectural Services.
- Specify 10 percent tolerances on air and water systems.
- Provide air balance table, room air changes per hour, design temperatures and humidity percentages, and air flows on contract documents.

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