

SECTION 15010

BASIC MECHANICAL REQUIREMENTS

Colorado School of Mines Standards are not intended and shall not be used as guide specifications. While it is expected that this information will be of assistance to architect and engineer, in developing plans, specifications, and contract documents on particular projects, no portion of this standard may be produced by photographic or other means in any specification intended to become a part of contract documents without explicit written prior approval of the Colorado School of Mines.

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:

1. Basic Mechanical Design requirements common to all Sections of Division 15.
2. Colorado School of Mines Facilities Management Basic Mechanical Design Policies and Standards.

1.02 REFERENCES

A. General:

1. For products or workmanship specified by Association, Trade, or Federal Standards, comply with requirements of the Standard, except when more rigid requirements are specified or are required by applicable Codes.
2. The Date of the Standard is that in effect as the Date of the Contract Documents, except when a specific Date is specified.

1.03 SYSTEM DESCRIPTION

A. University Philosophy:

1. This University, since its inception, has been intimately involved in large construction projects and has had to live with these projects long after the original designers passed on. In living with and maintaining these projects, certain facts have evolved which have become elemental bases in the design of any new project. Some of these are as listed in this Section, and others will be covered in appropriate subject Sections in these Design Guidelines.
2. A building designed for a specific department may not always be used by that department.
3. While there are no hard and fast criteria set forth on how to design a building so that it can later be used by a completely unknown department, there are certain basic facts that make this later transition somewhat easier. Such things as uniform window placement of reasonable sized windows, reasonable ceiling heights, adequate electrical facilities, easily adapted heating and cooling systems, adequate mechanical rooms, ample stairways, and other related items shall be made early in the design stage, and the University Construction Manager will be closely associated with securing these factors.
4. Buildings must sometimes be enlarged. Whenever this likelihood exists, provisions should be made to accomplish interconnections, upgrading and installation of mechanical systems.

5. It is basic policy to study the possibility of future needs (expansion, new equipment) at the time the basic design is being formulated. At least one layout shall be made showing expansion possibilities.
6. The University is extremely conscious of maintenance costs. We therefore look with concern on new and "untried" materials. We are opposed to experimentation on our projects. However, we look forward to considering innovative designs.
7. Exterior mechanical installations must not only be designed for proper functions, but must be considered in the aesthetics of building design. Large and unsightly installations shall be located to be hidden from public view or shall be appropriately enclosed.

All major air handling equipment shall be installed in a mechanical room accessible from the inside of the building. Rooftop air-handling units should be considered only when design constants do not permit installation inside the building structure and they can be hidden from view.

8. Drawings of elevations of structures must show mechanical installations, including installations projecting above parapet walls. If due consideration of aesthetics are not observed, the University Construction Manager will require complete re-design of HVAC systems and of structure elevations until a pleasing, well integrated design is achieved.
9. Basic design phase services shall allow the Architect to provide sufficient room for an orderly arrangement of equipment, piping, and conduit and the University shall continually monitor the work of Consultants to see that pleasing arrangements are achieved. Special consideration shall be given to heights of floor to ceiling spaces to allow for maintenance and concealment of systems, as much as practicable.
10. Special attention shall be given early in the design process to provide for sufficient and safe access space for maintenance of mechanical systems. Sufficient space implies the capability to replace major components with minor impact to the Building. Equipment shall be designed to be accessible and maintainable from floor level whenever possible. When not possible, permanent structures will be designed to minimize the necessity of such tools as ladders, hoists and portable lighting (i.e.: platforms and permanent ladders for overhead work, rail systems for removal of pumps in pits, adequate permanent lighting, etc.). The University shall not accept designs unless the drawings clearly indicate locations of ceiling and wall access panels and other necessary access space. **This needs to be emphasized to the contractors before and during construction.**
11. When renovating or retrofitting mechanical systems or spaces, review the need to remove asbestos insulation. Include the cost for removal and replacement with non-asbestos insulation.
12. Space is a precious commodity on campus. When equipment, wiring, piping, telecommunications cable, etc. is disconnected or "abandoned," it must be physically removed and disposed of as part of the project

B. Utilities:

1. In general, utilities will be included in Division 2 and work in this Division 15 will only extend to 5 feet outside of Building or Structure excavation perimeter.
2. Specify the following where exceptions do occur and Building Services extensions and connections are made to Public Utilities:

- a. Connection charges, membership fees, system development charges and the like, that in principle allow the right to obtain the services from the Utility will be arranged and paid for by the University.
 - b. Tap fees as they are known to the trade and are the charges for actual materials and labor for tapping, inspection and recording of the tap shall be arranged and paid for by the Division 15 Contractor.
 - c. In the event that the serving Utility Company installs their own taps, service, meters, etc., all costs imposed by this action shall be reviewed by the University. Extensions from termination points to connection with building services and systems will be the responsibility of the Division 15 Contractor.
- C. Meters:
1. Unless otherwise instructed all buildings will be metered for all utilities including electricity, gas, water, steam, or steam condensate as required, chilled water from central chiller, etc. Water meters need to be installed where make-up water is provided to cooling towers and evaporative-cooling modules.
- D. Energy Conservation Standards:
1. General Requirements:
 - a. The University is dedicated to the principle of conserving energy and will scrutinize proposed construction for means of reducing not only initial cost, but also long-range operating costs. The Architect must work in close cooperation with his Engineers to design new buildings and remodel existing buildings making the most efficient use of building materials and energy sources available. The International Energy Code shall be implemented, as a minimum.

LEED:

Guidelines shall be followed with the goal of achieving LEED Silver as a minimum. This includes the implementation of the appropriate ASHRAE standards (55, 62, 90, 129, etc.) and validation with accepted simulation programs, such as DOE2. If it is determined that the energy load will exceed the stated standards, a conference with the University representative will be required to determine the course of action. Re-design of problematic portions of the building will be required.

 - b. In the design of the HVAC and electrical systems, consideration must be given to building utilization by planning for conservation of energy during summer and winter vacations and for other periods of minimum occupancy. Research laboratories, spaces for animals, and other spaces that might require 24 hours/day operation must be serviced by systems separate from classroom/office systems that may require only 8 hours/day operation.
 - c. The capability of using alternate sources of energy is of great importance.
 - d. The Design Consultants shall provide an updated energy analysis to the University. It shall show the estimated use of energy for the structure.
 2. Building Construction Requirements:
 - a. The exterior envelope shall be given careful consideration. University maintenance, security, and utility costs indicate the need for restraint in

the use of large areas of glass. If large areas of glass are required for aesthetics, careful orientation of these areas for reduction of heat loss and heat gain must be made. Low emissivity glazing shall be used, with double-glazing set 3/4 inch apart, as a minimum.

- b. Windows, insofar as practicable, shall be provided with operable vent sections of minimum size in non-public areas only.
- c. Walls shall have R-19 or greater thermal resistance factor.
- d. Roof and ceiling combinations shall have R-30 or greater thermal resistance.
- e. Infiltration should not exceed ASHRAE Guidelines.
- f. Daylighting is encouraged, but with minimal glare and solar heat gain.

E. Design Calculation Procedures:

1. Calculations shall be based on methods and data from the most recent issues of the ASHRAE Handbook of Fundamentals.

LEED: Other requirements may apply.

2. Computer analysis, using only programs that meet LEED guidelines, will be acceptable

F. System Design Requirements:

1. Air conditioning systems shall be designed to conserve energy. Systems shall automatically adjust to the actual space load conditions to reduce energy consumption at partial space loads rather than falsely load and waste energy.
2. Design temperatures for heating and air conditioning systems shall be as follows:
 - a. Winter: 90 degrees F temperature difference between inside and outside conditions (-20 degrees F outside air temperature). Make-up air winter design temperature is -30 degrees F.
 - b. Summer: ASHRAE Summer 1% but 100 degrees F db and 59 degrees F wb outside conditions if air-intake is above a roof, and 95°/59° for systems with high make-up air intake. 73 degrees F dB, 63 degrees F wb inside conditions.
 - c. Special areas, such as computer rooms, animal areas, etc., will have temperature and humidity requirements transmitted to the Consultant by the University representative or Laboratory Consultant.
3. The University utilizes central EMS for central control of certain HVAC functions. Coordinate the tie-in of new HVAC systems with the EMS.
4. Occupied-unoccupied programming of systems should be initiated to shut-off ventilation air, exhaust air, fan system, pumps, etc., wherever possible. Where shut-down of systems cannot be accomplished during unoccupied hours, energy recovery systems should be considered. Each application should be examined independently to determine any special sources for obtaining recovery of usable energy. An economic analysis by the Consulting Engineer will be required to determine the feasibility of energy recovery systems before the University will render a decision on their acceptability. Four copies of this analysis shall be furnished by the Consultant to the University representative.

5. Fan coil units and radiation will be required in specific areas to facilitate shut-down of major fan units. Where necessary, the control of these units shall be coordinated with the controls on the air handling units.
 6. All air conditioning systems shall have air-economizer cycles where feasible. All systems that have economizer cycles shall be capable of running the cooling equipment independent of the economizer cycle controls. Furthermore, the economizer control shall not revert to the minimum outside air damper position for cooling season unless mechanical cooling is available.
 7. In order to take advantage of economizer cooling to the highest temperature possible, return air (RA) should be minimized. Therefore, RA dampers should be specified to be of tight sealing quality.
 8. All air conditioning, heating, ventilating and exhaust systems shall be matched to the maximum required performance. The use of variable volume supply and exhaust air systems is encouraged to compensate for diversities in loads and to reduce equipment sizes. Space supply air outlets should be aspirating-type to prevent "dumping" of air into occupied spaces. Displacement cooling may be considered.
 9. Interior spaces requiring cooling the year around should be handled independently from perimeter areas requiring heating during the winter and cooling during summer. Interior areas should be supplied from a variable volume cooling system utilizing an air economizer cycle. The perimeter systems should utilize economizer cycles when cooling is required and minimum ventilation rates when heating is required. VAV terminal units shall be allowed full shut-off.
 10. Buildings having a substantial amount of exhaust for research purposes have a propensity to overcool during the cooling season due to minimum settings on air supply. In order to avoid hot-water reheat, dual duct systems should be considered. Appropriate make-up air shall be provided.
 11. Provide for two-stage filtration (30% / MERV 7 and 60% / MERV 11) upstream of all air handling coils. Heat-recovery coils shall have 60% (MERV 11) filters.
LEED: Filtration shall be 30% (MERV 7) and 85% (MERV 13).
 12. All coils shall have access for cleaning, including re-heat coils in, for example, VAV terminals.
 13. Elevator shaft venting: In order to minimize drafts, heat loss and elevator door "whistling", it is necessary to install a motorized damper for elevator shaft venting, interlocked to the fire-alarm and control system.

The damper shall be operated as indicated in "Control Sequence of Operation" of the control section
 14. Outside air ventilation shall be per latest approved version of ASHRAE Standard 62 during the time the spaces are occupied. Judicious use of CO₂ sensors is encouraged.
 15. Pressure gages are required across all AHU coils and filters banks (filter and pre-filter combined).
 16. See Section 1.05, Submittals, for fan requirements
- G. Criteria for Selection of Equipment:
1. The following criteria shall be employed in the selection of equipment:

- a. Fans selected for operation above 6" total static pressure must be approved by the responsible University Engineer.
- b. MINES uses electrical centrifugal chillers and chiller plants serving 3-5 buildings. Design new and existing buildings to use existing chiller plants or new chiller plants with expansion capabilities. Construction budget will be required to carry full cost of air conditioning regardless of whether the unit is located in the building or chilled water is used from the chiller plant.
- c. Refer to ASHRAE 90 for minimum Energy Efficiency Ratios (EER) allowable for all other compressors.
- d. Water-cooled or evaporative condensers are acceptable depending upon job requirements and necessities. Water-type cooling towers are preferred, to conserve energy, and shall generally be considered on systems 80 tons and larger. On units below 80 tons, an economic evaluation, including cost of maintenance should be made to determine if the condensing unit will be air cooled or water cooled. Cooling tower fan motor loads shall not exceed 0.06 H.P. per ton of chiller capacity. Reduced condenser water temperatures should be utilized when possible to reduce the chiller electrical consumption.
- e. Air-cooled condensers shall be capable of operating at 95°F ambient temperature with 30°F temperature difference between air entering and leaving the condenser. Air-cooled condensers on roofs shall be capable of operating at 105°F ambient temperatures.
- f. Small water-cooled DX Units or research equipment that utilizes tap water for condensing, after which the water is disposed of in the drain, will not be permitted. In every instance, review by MINES engineering staff is required.
- g. Variable-speed controllers (VSC) are acceptable. Electrical by-pass switches are not required. See section 15050 for VSC minimum requirements.

H. Design Documents:

1. Drawings:

- a. All drawings shall be on Mylar or equivalent material. Computer-aided drawing is required. Final CAD drawings shall be updated with as-built conditions and equipment data before delivery to University. CAD disks shall be provided as well.
- b. They shall include date of issue, University job number and indication on each sheet of number of sheets issued (e.g., Sheet ___ of ___). Drawings shall follow MINES requirements.
- c. All equipment designations, schedules and descriptions shall be indicated on the Drawings. The Specifications may be used to clarify and complement or to describe minimum performance standards and operating instructions. We have had consistent problems and waste of time cross-referencing Drawings and Specifications when equipment parameters are listed in the Specifications. Therefore, we require that all the equipment parameters be listed on the Drawings, in table form (schedule), whenever possible. Single, distinct equipment may be described in non-table form. Include two columns indicating what the

- equipment is used for (e.g. Exhaust Hood, Room 258, Supply Air, First Floor) and room number where located.
- d. Plumbing isometrics shall be included.
 - e. Components shall be labeled per the list in Appendix 1 of this section.
2. Specifications:
- a. We require the standard long-form of specification. Our experience with the short form has been unsatisfactory.
 - b. We require the Specifications be set up in specific CSI Sections, with each Section having the pages numbered for that section only.
3. Consultant Submittal Requirements
- a. Schematic Design
 1. Narrative: Narrative description of the proposed mechanical systems.
 2. Plumbing & Piping
 - a. Restroom locations and fixtures (quantity and type).
 - b. Piping risers.
 - c. Location of water, sanitary sewer, storm sewer and sprinkler services to the building.
 - d. Tentative fixture schedule.
 - e. Location, sizes and types of water heaters, heat exchangers, and flues if required.
 - f. Provide a fixture-count calculation sheet.
 3. HVAC
 - a. HVAC load calculations
 - b. Equipment schedules with tentative sizes, capacities, features, etc.
 - c. Mechanical-room drawings, showing locations and sizes of fans, pumps, compressors, heat-exchangers, etc.
 - d. Shaft locations and sizes.
 - b. Design Development
 1. Narrative
 - a. Updated narrative from the one included in the Schematic Design documents
 2. Plumbing & Piping
 - a. Plans of each floor, noting fixture locations and types. Indicate routing of main distribution lines with tentative sizes.
 - b. General arrangement of all piping systems (piping, heating and cooling, and FP).

- c. Location of water, sanitary sewer, storm sewer and sprinkler services to the building.
 - d. Tentative fixture schedule.
 - e. Location, sizes and types of water heaters, heat exchangers, and flues if required.
 - f. Provide a fixture-count calculation sheet.
3. HVAC
- a. Plans of each floor, showing single-line duct layouts (as a minimum), equipment location, and typical heating and cooling devices (e.g., a VAV-box and branches with diffusers, BBR, CUHs and UHs).
 - b. Equipment schedules with tentative sizes, capacities, features, etc.
 - c. Mechanical-room drawings, showing locations and sizes of fans, pumps, compressors, heat exchangers, etc. Show elevations or cross-sections to ascertain that equipment fits vertically.
 - d. HVAC load calculations.
4. Specifications
- a. Outline specifications are not required. It is expected that the mechanical consultant will provide an informal review set of drawings and specifications at the 70% level of mechanical design.
 - b. Partial CD's (70%)
- c. Provide drawings for informal review at 70% of mechanical design.
- 1. Outline specifications are not required. Provide "best effort" full specifications.
- d. Drawings
- 1. Drawings at all stages of design shall have room numbers corresponding to those in architectural drawings.
- e. Commissioning
- 1. Include appropriate commissioning checklists in the specifications.
- f. Codes:
- 1. The latest Edition of the International Mechanical Code, Plumbing Code and the Fire Code shall apply to the Project Design except where University Standards are more stringent.
- g. Coordinate with the Architect to provide a curbed floor area for storage of on-site water-treatment chemicals, following water-treatment consultant's recommendations.

1.04 PROOF OF PERFORMANCE

- A. Require that all pressurized piping be pressure tested and witnessed by the design engineer and MINES.
 - B. Require that all new ductwork in new systems be pressure-tested per SMACNA, from AHUs to upstream of terminal control devices (e.g., VAV boxes).
 - C. Include commissioning.
- 1.05 SUBMITTALS
- A. Specify Contractor to:
 - 1. Submit Samples, Shop Drawings and Product Data as required by various Sections of Division 15 in accordance with Section 01300 – Submittals.
 - 2. "Submit detailed shop drawings for all fan systems having structural frame supports for the fan housing. These must include solid rotor shaft dimensions, wheel weight, bearing center-to-center distances, bearings, bearing support pedestals and structure, etc. None of the above-cited items are to be considered as being "unavailable" or "proprietary". Relevant sketches giving pertinent details are acceptable. The design resonant speed of the fan system shall be a minimum of 25% above the fan operating speed, considering both wheel mass and inertia. Appropriate engineering calculations must be available to support the design resonant speed value and to insure that the bearing support structure has adequate stiffness in all three directions (lateral, axial, and vertical). The installed, operating fan bearing motions (inboard and outboard) shall not exceed 1.5 mils peak-to-peak in any direction when measured in the "filter out" measurement mode at any operating speed; "filter in" mode measurements are not acceptable. The instrument system used must have a flat response down to 120 RPM. Fan speed shall not exceed 1200 RPM. Schematic VIBR-1 (see appendix) shall be used to submit fan, wheel and bearing information for each fan.

Design Resonant Speed is that speed which corresponds to the natural frequency of the spring-mass system consisting of the rotating components, bearing lubrication and housing, and supporting pedestal (supporting floor, foundation, etc., considered to be infinitely rigid)."
 - 3. Prepare and submit three copies of Operation and Maintenance Data for Division 15. Also, provide three of each of the building monitoring and control systems and the life-safety systems.
 - 4. "Mechanical contractor shall obtain approval in writing from balancing contractor for type and size of balancing devices."
 - 5. Specify that "The University requires all plumbing work be performed under the direct supervision of licensed plumbers (4-year), with a ratio of not more than two apprentices per journeyman. The requirement also applies to pipefitters."
 - 6. Specify that "The University requires all HVAC work to be performed by a current holder of a Denver City and County HVAC Journeymen, ratio of one apprentice per journeymen. This shall apply for refrigeration work also. Certificate holders to have a current refrigeration certificate, ratio of one Journeyman to apprentice shall apply.
- 1.06 OPERATION AND MAINTENANCE INFORMATION
- A. The manuals of Operation and Maintenance data bound in 8-1/2 by 11 inch three-ring side binders with durable hard plastic covers. The University shall receive the quantity of O&M manuals stated in Division 1. They shall include:
 - 1. Warranties.

2. Alphabetical list of all system components including the name, address, and 24-hour phone number of the company responsible for servicing each item during the first year's operation.
 3. Maintenance Instructions, including valves, valve tag and other identified equipment lists, proper lubricants and lubricating instructions for each piece of equipment and necessary cleaning/replacing/adjusting schedules.
 4. Manufacturer's Data on each piece of equipment, including:
 - a. Installation Instructions.
 - b. Drawings and Specifications (reviewed and accepted Shop Drawings).
 - c. Parts Lists.
 - d. Complete Wiring and Temperature Control Diagrams (reviewed and accepted Shop Drawings).
 5. Testing, adjusting and balancing (TAB) report.
 6. Signed-off commissioning checklists.
 7. Appropriate start-up information by factory representative.
 8. On-site dynamic balancing report by independent balancing firms of all labs.
- B. In addition to the "Operation and Maintenance Manual", and keyed to it, the equipment shall be identified and tagged as specified in Section 15190 - Mechanical Identification including the following:
1. Identify all starters, disconnect switches, and manually operated controls, except integral equipment switches with permanently applied, legible markers corresponding to operating instructions in the "Operation and Maintenance Manual". Coordinate with University Preventive Maintenance personnel.
- C. Division 15 Contractor shall be responsible for scheduling instructional meetings for maintenance personnel on the proper operation and maintenance of all mechanical systems, using the "Operation and Maintenance Manual" as a guide.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

3.01 WATER TAPS

- A. In general, we prefer "hot taps" over "dry taps" because it is so difficult to schedule outages.

3.02 MOUNTING OF EQUIPMENT

- A. Specify that equipment shall be anchored with anchors extending through the housekeeping pad or curb into the floor. This is illustrated in the schematic associated with section 03200 of the MINES standards.

END OF SECTION