

Basis of Design

This section applies to the selection and installation of air handling units and ventilation fans.

Design Criteria

- Ensuring that efficiency is not compromised, specify fan speeds less than 1,000 rpm to reduce noise levels and increase equipment life. Review with Campus Engineering any applications where fan speeds greater than 1000 rpm are intended for use.
- Provide weather protected fans installed near the building roof. Fan installation in penthouses is preferred. The fan should be the last element of the exhaust system to assure that the ductwork throughout the building is under negative pressure.
- Install fans to be readily accessible for maintenance and inspection without entering the plenum. If exhaust fans are located inside a penthouse, consider the ventilation needs of maintenance workers.
- Discuss laboratory ventilation interlocks and standby power requirements with EH&S and Campus Engineering.
- Coordinate the mechanical design with fume hood selection and location to achieve design performance criteria listed in the EH&S Laboratory Safety Design Guide.
- Avoid natural ventilation via operable windows at perimeter rooms because occupants are not likely to open windows during cold winter months. Natural ventilation at perimeter rooms shall be by trickle vents or other methods that would not cause discomfort for the occupants. Discuss with Campus Engineering.
- In laboratories, the minimum ventilation rate will be per EHS laboratory safety design guide. Although the ceiling may exceed 10 feet, use the 10 feet dimension as the effective room height, or actual dimension if less than 10 feet, when calculating the air exchange rate. Because of the processes occurring in most laboratory buildings, one-way air systems (no recirculation) will usually be required. Discuss with Campus Engineering and EHS if you have questions. See EH&S Laboratory Safety Design Guide.
- Mechanical and electrical rooms will be ventilated for temperature control. Usually the temperature will be controlled to 90° F unless there are specific equipment temperature requirements. Ventilation can be controlled by a thermostat, as long as an override is provided for Physical Plant use. Provide minimum outside air to all mechanical and electrical rooms as part of the ventilation system.
- General use storage rooms may eventually become offices and must have provisions for future ventilation. The ductwork and piping systems shall be sized for this eventual conversion. Storage rooms are not considered unoccupied areas.
- To maintain the best possible indoor air quality, the location of the air intake(s) is very important and must be discussed with Campus Engineering and EH&S. Locate the intakes to avoid contamination from streets, exhaust vents, loading docks, and other sources of contamination. For air intake requirements see EH&S Laboratory Safety Design Guide. Make provisions for an additional 10 feet increase in height if air quality problems arise in the future.
- To protect the air intake locate all building exhausts as remotely as possible from the intake. All fume exhaust systems must be located on the roof and discharge vertically.

- Provide the air intake area with easily cleaned screens and drains to allow for the delivery of clean dry air to the ventilation system. Provide bird screen to keep birds, leaves and other material out of the system.
- For airflow simulation study requirements for all buildings see EH&S Laboratory Safety Design Guide.
- Most building systems will be large, built-up units, in the 20,000 to 75,000 CFM range. The use of small package units is discouraged.
- Separate ventilation systems or zones may be required for separate occupancy uses, such as libraries and auditoria. The occupancy schedule of these areas will not always be the same. Make provisions to run these areas when the remainder of the building is not in operation.
- Provide building copy/duplicating rooms and other rooms that contain several personal computer printers with exhaust systems to eliminate the migration of dust and chemicals. To maintain adequate indoor air quality, do not recirculate the air from these rooms.
- Do not use fan rooms and mechanical rooms as supply or relief/exhaust air plenums. Duct all outside air and relief/exhaust air ducts to outdoors.
- For fume exhaust, see Ductwork and Duct Accessories section and EH&S Laboratory Guide Manual.
- Provide ventilation through centrally ducted systems, not individual ventilating assemblies such as fan coil units or unit ventilators.
- Minimize return air plenums. Provide ducted return air system. Discuss with Campus Engineering if plenum returns are proposed.
- For separate snorkel exhaust system requirements see EH&S Laboratory Safety Design Guide.
- When connecting to existing systems, use the actual operating conditions (temperatures, air flow volumes, and pressures), not the design values shown on the as-built drawings. As an example, the as-built drawings show a cold deck temperature of 55°F, whereas the actual operating conditions can only maintain a cold duct temperature of 60°F.
- Avoid roof-mounted equipment. Provide weatherproof enclosures and screening for roof mounted equipment.
- Indicate all systems diversities that the balancer must account for in the completion of the work.
- Use outside air to meet the cooling requirements whenever possible. For building systems without mechanical cooling, design the HVAC system (fans, ductwork, etc.) so the space temperature does not exceed ambient temperature by more than 7°F.

Design Evaluation

The following information is required to evaluate the design:

- Schematic Design Phase: Identify all system fans, and include single line system flow diagrams, outside air intake and exhaust outlet locations and design calculations. Special occupancy zones must be called out and fan systems identified.
- Design Development Phase: Provide single line duct layouts, updated single line system flow diagrams, equipment layout and access indications, outside air intake calculations, equipment schedules, design calculations, and an outline of specifications.
- Construction Document Phase: Provide double line duct layouts, equipment layout and access indications, final single line system flow diagrams, equipment schedules, design calculations, and specifications.

Construction Submittals

- Provide industry standard submittal requirements.

Related Sections

- Facilities Services Design Guide – Mechanical - General Requirements
- Facilities Services Design Guide – Mechanical - Heating, Ventilating and Air Conditioning
 - Process and Environmental Chilled Water
 - Central Cooling Water
 - Steam and Condensate
 - Hydronic Heating
 - Refrigeration
 - Filters
 - Coils
 - Ductwork and Duct Accessories
 - HVAC and HVAC Piping Pressure Testing
- Facilities Services Design Guide – Mechanical - Piping, Valves & Accessories
- Facilities Services Design Guide – Mechanical - Hangers and Supports
- Facilities Services Design Guide – Mechanical - Motors and VFDs
- Facilities Services Design Guide – Mechanical - Metering and Gauges
- Facilities Services Design Guide – Mechanical - Nonstructural Component Seismic Design
- Facilities Services Design Guide – Mechanical - Identification
- Facilities Services Design Guide – Mechanical - Insulation
- Facilities Services Design Guide – Mechanical - Water Treatment and Flushing

- Facilities Services Design Guide – Mechanical - Noise and Vibration Control
- Facilities Services Design Guide – Mechanical - Cold/Environmental Rooms
- Facilities Services Design Guide – Mechanical - Computer Server Rooms
- Facilities Services Design Guide – Mechanical - Environmental Control Systems
- Environmental Health & Safety Design Guide – Sprinkler Protection & Standpipes
- Facilities Services Design Guide – Mechanical - Testing, Adjusting and Balancing
- Facilities Services Design Guide – Mechanical - Commissioning

Products, Material and Equipment

Fume Exhaust Fans

- Provide fans with the following:
 - 1) Outboard "split" bearings,
 - 2) Shaft seal,
 - 3) An access door,
 - 4) Multiple 150 percent rated belts, or direct drive. In designing for explosion and fire control, the fan shall be of the non-sparking construction and the V-belt drive shall be non-conductive.
- Provide chemical resistant fan system.
- Weld or permanently seal fan housing to avoid air leakage from the wheel shaft and discharge.
- Fume exhaust fans shall be arrangement 1 or 9, overhung wheel type with bearings outside air stream. Fans shall have two bearings; split-case with split inner and outer races and cage.
- Choose fan type as follows:
 - 1) Use straight-radial fans for systems handling moderate to heavy quantities of particulate matter in air.
 - 2) Use backward-inclined fans for systems handling relatively clean (low particulate) air.
 - 3) Provide perchloric acid hood with an induction type fan.
- Manifold fume exhaust systems shall use constant volume fans with make-up air/outside air bypass.

Installation, Fabrication and Construction

General

- During storage, transport, and installation prior to start-up, cover the air handlers with plywood and/or plastic as necessary to keep them dry, clean, and protected from damage. Provide heaters and/or dehumidifiers if necessary to prevent condensation inside air handlers

prior to start-up. Provide temperature/humidity data loggers in units in transit and during storage. Air handlers with insulation that has been wet are unacceptable.

- Thoroughly clean equipment casings of debris and small particles of rubbish and dust before installing and making final duct connections.
- Do not start the fans until the Owner and the mechanical design consultant have approved the level of cleanliness of the air distribution system. Provide full access to the system for the inspection of cleanliness prior to start-up.
- The preferred fan design is single inlet, single width centrifugal type with backward inclined airfoil blades; however, utilization of airfoils, propellers, and duct axial flow fans is acceptable where appropriate.
- Fan volume control via variable frequency drives must be provided when the system has features to cause a variance in volume. Do not provide VFDs on manifolded fume exhaust systems unless a minimum of 2500 fpm exit stack velocity can be maintained. Refer to section Mechanical – Testing, Adjusting, and Balancing for balancing information related to VFDs. Provide rigid structural steel base for both fan and motor with slide rails for drive adjustment. Hinged motor bases are not acceptable.
- Provide ball-type fan bearings (selected for extended life), lubricated with grease fittings extended through fan casing for easy access.
- Provide each fan drive with an easily removable guard assembly protecting drive and shaft, with access for tachometer use.

Air Handlers

- Air handler walls shall be double-walled panels with a minimum of 4 inches of fiberglass insulation, 16 gauge exterior galvanized steel; and 22 gauge internal galvanized steel perforated except downstream of cooling coils and in outside air intakes.
 - 1) Floor: non-skid floor that extends up the walls to prevent leakage in the event of water accumulation.
 - 2) For access doors, use the same metal gauges and insulation levels as are specified for the rest of unit.
 - 3) Downstream from cooling coils, double-walled internal duct insulation with a solid metal surface exposed to the air stream is preferred. If perforated (rather than solid) metal liner is necessary to reduce noise levels, underneath the metal liner provide a lining with FSK facing.
- Angle iron bracing inside plenums shall be galvanized.
- Provide access doors to each area between the coils, filters and fan. The access between the coils, filters and fan must be a minimum of 18 inches (preferably 24 to 36 inches).

Fume Hood Fans

- Provide access for fan maintenance.
- Mount the fan with vibration isolators.
- Provide weather protected fans installed near the building roof. Fan installation in penthouses is preferred. The fan should be the last element of the system to assure that the ductwork throughout the building is under negative pressure.

- Install fans to be readily accessible for maintenance and inspection without entering the plenum. If exhaust fans are located inside a penthouse, consider the ventilation needs of maintenance workers.
- Discuss fire alarm interlocks to fume exhaust fans and standby power requirements with EH&S and Campus Engineering.
- Coordinate Fume Hood selection and location with architectural to achieve design performance criteria listed in the EH&S Laboratory Safety Design Guide.
- Provide laboratory buildings with at least half of the ventilation (supply and exhaust) during an electrical power outage. Account for building pressure differentials during electrical outages to allow egress.
- Provide perchloric acid systems, including duct fans and hood, with an internal wash-down system that meets the following requirements:
 - 1) Design the perchloric acid fume hood system to provide as complete a wash-down with all ductwork at 45 degrees or less from vertical to drain back to the fume hood.
 - 2) Provide fan casings and hood bottoms with continuous gravity drainage to the acid resistant waste.
 - 3) The wash down system shall be activated by a manual valve located adjacent to the fume hood.
 - 4) Prior to acceptance, testing of the wash-down system must be witnessed and approved by Owner's witness and EH&S.

END OF DESIGN GUIDE SECTION