Design Standard
Basic HVAC System Design

Purpose:

The purpose of this document is to standardize the basic elements of the HVAC system design process. This design standard has the purpose of creating a consistent application of HVAC system design throughout the South San Francisco Unified School District thereby achieving a standard of quality for maintenance, energy efficiency, and reliability throughout all renovation and new building projects.

Design Standard:

HVAC Calculation

- Outside air temperatures: use in calculating HVAC system capacities.
- Lighting Loads: Lighting loads shall be calculated at CEC T-24 Watt per square foot values during preliminary design. Engineers shall execute final calculations upon selection of final lighting fixture selections.
- Equipment Loads: Equipment loads are variable and should be based on actual equipment to be installed in each location. Engineer shall apply diversity factors so as not to oversize central HVAC systems.
- Thermal Mass: Thermal mass shall be considered during calculations as a method to offset cooling loads.
- U-Values for Walls and Roofs: Loads shall be calculated at CEC T-24 allowances during preliminary design. Engineers shall execute final calculations upon selection of final building façade materials.
- U-Values for Solar Heat gain Factors for Windows: Loads shall be calculated at CEC T-24 allowances during preliminary design. Engineers shall execute final calculations upon selection of final building façade materials.
- Cooling system pick-up capacity: 10% of total load
- Heating system pick-up capacity: 25% of total load
- All calculations shall be completed utilizing DOE approved calculation software.
- Pipe sizing calculations: 4.0’/100’HD for main piping; 3.5’/100’ HD for branch piping; 7 fps maximum velocity in occupied spaces.

- Duct sizing calculations: equal friction method - 0.1”/100’ for main ductwork (never exceed 2,000 feet per minute); 0.08”/100’ for low pressure branch ductwork (never exceed 800 feet per minute). Lower velocities may be needed for acoustical purposes.
- Return air systems – Return air ducts shall be sized on the equal friction method at 0.08”/100’ (never exceed 1,500 feet per minute). Design plenum return air systems for low pressure drops. Design transfer air systems at 250 feet per minute to minimize pressure drop at grill faces, and at 500 fpm at open air spaces across the net free area. For multiple, cascading transfer openings the total pressure drop shall not exceed the allowable pressure drop for an individual opening.
- Interior temperature requirements:
  - General conditions
    - Summer time cooling design 73°F +/- 3°F, no RH control (no cooling control except through ventilation for buildings deemed not to have cooling systems)
    - Winter time heating design: 70°F +/- 3°F, no RH control
- Acoustical and Vibration Calculations:
  - Acoustical calculations shall be completed by a professional specializing in the science of sound transmission, acoustics, and vibration.
  - Design shall conform to ASHRAE Chapter “Sound and Vibration Control”, latest edition and the SSFUSD Acoustical Design Standards.

Outside Air Make-up and Ventilation

- Utilize CEC T-24 and/or ASHRAE Standard 62 (whichever is most stringent), latest edition, to determine outside air ventilation flow rates. Indicate quantities of minimum outside air on all equipment schedules.
- Outside air for ventilation and make-up shall be brought from a fresh source of air. Outside air openings and operable building systems shall be located at a minimum of 15-0” from any permanent or temporary points of:
  - Boiler exhaust
  - Kilns
  - exhaust air
  - plumbing vents
  - areas of objectionable odor
  - locate away from loading docks, parking lots, adjacent roadways, etc.

  - 30'-0" separation from non-environmental exhaust systems (as defined by the CMC) such as kitchen exhaust, lab fume hood exhaust, garage exhaust, etc. Increase separation where openings are downwind from sources listed above.

- Design outside air intakes to eliminate the possibility of water carry over. Always utilize drainable weatherproof type louvers at intakes.
- Determine if natural ventilation can be utilized for comfort cooling either by itself or as part of a mixed-mode system. Prior to locating intakes, consider:
  - pollution sources
  - acoustical interferences
  - security
  - airflow patterns via CFD modeling
- Consider the use of ultraviolet lamps at AHU outside air coils to kill bacteria and mold that may grow in air handling units. Ultraviolet lamps will not only kill bacteria and mold but also have the advantage of reducing maintenance for coil cleaning.

Equipment Selection

- HVAC Systems: Specific system types are either addressed in the program or where a system is not indicated shall be addressed by the engineer of record for the project based on:
  - Lifecycle cost analysis to include first cost, operating cost, maintenance cost, energy cost
  - Reliability
  - Temperature control
  - Noise level
  - System complexity
  - Life expectancy – Minimum life expectancy for equipment shall be 25 years
  - Susceptibility to vandalism
  - Heat pumps to be self-contained type only and require District approval.
  - Existing boilers will be phased out over time. Do not design for new boilers.
- Equipment General:
  - Provide an integrated design so that each element of the building is carefully considered.

- Utilize shading, landscape, canopies, blinds, building thermal mass, etc. to reduce heating and cooling loads and minimize equipments sizes.
- Rooftop equipment may attracts birds who roost in/around the units and damage equipment Designers who specify the installation or repair of rooftop equipment shall also specify the installation of enclosures to protect existing piping, motors, etc from bird infiltration. Specify cages, solid metal, or any other material which will withstand the weather, moisture, etc.

- Fans:
  - Fans shall be selected on a stable point of operation of the fan curve. Fan selection shall be based on methods in the ASHRAE Handbook, most recent edition.
  - Select Motor sizes and speed should provide a 15% safety factor for deviation in fan static pressure and future airflow increases.
  - Static pressure of fans shall be determined from pressure drop calculations (based on the most hydraulically remote location) including:
    - ductwork
    - fittings
    - diffusers/grilles
    - ductwork accessories
    - system effects
    - specialties and appurtenances
    - discharge velocity pressure
  - Select fan noise sound and pressure levels to assure quite operation per acoustical requirements above.
  - Kitchen Grease Exhaust: Fans shall be UL listed for such service. Provide with drain. Consider location of kitchen smoke exhaust with regards to campus views, deterioration of building façade, and odors.
  - Fume Hood Exhaust Fans: Fans shall be UL listed for such service. Provide explosion proof systems with appropriate coatings to prevent chemical action on fan housing.

- Heating Coils
  - Design heating water coils on basis of a nominal 600 foot per minute face velocity.
  - All heating coils shall be pipe counterflow of refrigerant against airflow.
  - Select the Cv of each coil control valve at design conditions.

- Design with upward flow through coil and air vents at all high points of coils to eliminate trapped air.
- At a minimum design with isolation valves on supply and return, two or three way control valve based on pumping system design, drain, flexible connections, and temperature gage.

- Air Distribution Devices
  - At diffusers and grilles at gymnasiums, provide protection from balls and vandalism.
  - Supply Diffusers:
    - Preferred method of air distribution due to aspiration and entrainment of room air (reduction of drafts and more even room temperature profiles) as well as the ability to distribute air in many different directions.
    - Supply air grilles shall be sized based on manufacture's airflow, noise criteria, mounting height, and pressure drop data.
  - Supply Grilles:
    - Avoid wall grilles where possible. Wall grilles have a lack of aspirating qualities and when discharging in cooling can create a perceived feeling of drafts. Where designed, use care. Utilizes a larger width to height aspect ratio for maximum induction of room air. Utilize double deflection type grilles to maximize adjustability. Do not throw air longer than 15-20 feet in rooms with low ceilings (below 9 feet).
    - Supply air grilles shall be sized based on manufacture's airflow, noise criteria, mounting height, and pressure drop data. Do not exceed 500 feet per minute.
  - Return Air Grilles
    - Locate to aid in contaminant displacement.
    - Design for low pressure loss in return plenum systems to assure that rooms do not get over-pressurized.
    - Return air grilles shall be sized based on manufacture's airflow, noise criteria, mounting height, and pressure drop data. Do not exceed 400 feet per minute for ducted systems and 250 feet per minute for plenum return systems.
- Sound Attenuation and Vibration Control
  - Where required utilize sound traps or acoustical duct lining to mitigate noise attributable to HVAC equipment.

- Size of sound traps and length to be provided by an acoustical engineer after completion of calculations.
- Length of acoustical lining to be provided by an acoustical engineer after completion of calculations.
- Provide vibration isolation devices as required to meet ASHRAE recommendations for vibration transmission.

- Pumps
  - Select systems with two pumps. Deliver 100% capacity with both pumps operating in parallel. When one pump shuts down, a single pump shall be capable of providing 75-80% of the total capacity. Due to cost considerations standby pumps are not required unless there is a specific concern for redundancy.
  - For economical design and energy efficiency, end suction, base mounted pumps and in-line pumps should be used for most systems except when the systems become very large.
  - Dynamic head of pumps shall be determined from pressure drop calculations (based on the most hydraulically remote location) including:
    - piping
    - fittings
    - valves
    - coils
    - system effects
    - specialties and appurtenances
  - Pumps shall be capable of being removed for maintenance without having to drain the entire system.

- Temperature Control and Zoning
  - Individual temperature controls will be based on function, exposure, and Owner request.
  - Each conference room, lobby, classroom, break area shall be on a separate temperature control zone.
  - Perimeter closed offices will be provided with no more than three to five offices per group of offices along the same orientation. This requirement may be relaxed when utilizing variable volume diffusers and terminal units are used primarily as a means of pressure control and reheat, however, group variable volume diffusers along the same orientation.

- Large group spaces shall allow user-adjustable controls restricted to +/- 3°F with a time-out after 2 hours.

- Specialty Considerations
  - Specialty Pressure Requirements and Exhaust Systems
    - Specific rooms shall be designed to be at a negative pressure to adjoining spaces and to be exhausted 100%. These rooms include but are not limited to: restrooms, certain science classrooms (confirm with activity and use), kitchens, janitor closets, copy rooms, food service rooms, locker rooms, shower facilities, dark rooms, art classrooms (confirm with activity and use), boiler rooms, etc. Provide relief air at doors.
    - Areas with products of combustion need removal of the products and a source of combustion air.
  - Food Service Facilities
    - The kitchen shall be designed with separate exhaust systems for each hood allowing each hood to be separately controlled. Fans shall be at the end of the exhaust system and located in the exhaust duct. Exhaust airflow shall be at a rate of 1500 feet per minute minimum to create a capture velocity. No duct accessories are allowed in the kitchen exhaust system.
    - Provide separate exhaust systems for dishwashing. Ductwork shall be non-corrosive stainless steel and pitched for drainage. A duct drain shall be provided at the low point of the ductwork. Do not trap water in the duct.
    - Exhaust ductwork shall be specifically designed of materials compatible for kitchen grease exhaust
    - Make up air can either be provided from make-up air handlers or by transfer of air from adjoining spaces, Code permitting.
    - The make-up air and exhaust air systems shall be interlocked.

Sustainable Design Practices

- The South San Francisco Unified School District has a desire to build buildings utilizing sustainable design techniques. Each strategy needs to be integrated appropriately into their respective projects. Development of design strategies for each item is beyond the scope of this Design Standard and requires careful consideration for proper application.

Approved Manufacturers:

- Not Applicable

Substitutes Allowed:

- Not Applicable

Associated Design Standards

- Division 1 Design Standard Codes & Standards

End of Document