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5.2 HVAC Systems

Heating, ventilating, and air-conditioning systems can be the largest energy consumers in Federal buildings. HVAC systems provide heating, cooling, humidity control, filtration, fresh air makeup, building pressure control, and comfort control—all requiring minimal interaction between the occupants and the system. Properly designed, installed, and maintained HVAC systems are efficient, provide comfort to the occupants, and inhibit the growth of molds and fungi. Well-designed, energy-efficient HVAC systems are essential in Federal buildings and contribute to employee productivity. Boilers, air distribution systems, chillers, absorption cooling systems, desiccant dehumidification, ground-source heat pumps, and new HVAC technologies are covered in the sections that follow.

Opportunities

Consider upgrading or replacing existing HVAC systems with more efficient ones if current equipment is old and inefficient; if loads have changed as a result of other conservation measures or changes in building occupancy; if control is poor; if implementing new ventilation standards has caused capacity problems; or if moisture or other indoor air quality problems exist. Be sure to have a plan in place for equipment change-out and failure. The phase-out of CFCs is another factor encouraging chiller replacement. In all these cases, an *integrated* approach should be utilized that looks at the entire cooling system and the entire building to take advantage of synergies that allow for *downsizing*, as well as boosting the efficiency of, a replacement chiller.

Technical Information

Strategies for reducing HVAC operating costs in large facilities include the following:

Reduce HVAC loads. By reducing building loads, less heating and cooling energy is expended. Load reduction measures include adding insulation; shading harsh wind and sun exposures with trees, shade screens, awnings, or window treatments and minimizing the use of heat-producing equipment, such as office equipment and computers; daylighting; controlling interior lighting; and capturing heat from exhaust air. See *Part 4* of this guide for more on building design issues.

Incorporate building automation/control systems. These systems can be added or upgraded to improve the overall performance of the building, including the HVAC equipment. Perhaps the simplest measure and the first to be considered should be to ensure that HVAC systems are in "setback" mode during unoccupied periods. Existing control systems will often accommodate this very simple measure. Sections 5.6, 5.6.1, and 5.4.4 (for lighting) address energy controls in more detail.

Optimize for part-load conditions. Buildings usually operate under conditions in which the full heating or cooling capacity is not required. Therefore, significant improvements in annual efficiency will result from giving special consideration to part-load conditions. Staging multiple chillers or boilers to meet varying demand greatly improves efficiencies at low and moderate building loads. Pairing *different-sized* chillers and boilers in parallel offers greater flexibility in output while maintaining top performance. Units should be staged with microprocessor controls to optimize system performance.

Isolate off-line chillers and boilers. In parallel systems, off-line equipment should be isolated from cooling towers and distribution loops. With reduced pumping needs, circulation pumps can be shut off or modulated with variable-speed drives.

Use economizers. In climates with seasons having moderate temperatures and humidity, adding air- and water-side economizer capabilities can be cost-effective. When ambient conditions permit, outside air provides space conditioning without the use of the cooling plant. To prevent the inappropriate introduction of outside air, careful attention must be given to economizer logic, controls, and maintenance. With a water-side economizer, cooling is provided by the cooling tower without the use of the chiller.

Remember that ventilation systems have a tremendous impact on energy use because of the high costs associated with heating or cooling outside air. Buildings should be ventilated according to ASHRAE Standard 62. The outside air requirements—15 to 20 cfm (7.1–9.5 L/s) per person in most commercial buildings—of Standard 62's most recent version (62-1989) do not apply to buildings constructed before it was published, although for new additions of 25% or more, this "grandfathering" is not permitted by the major building codes. The indoor air quality benefits of complying with ASHRAE 62-1989, such as higher productivity and decreased sick leave, may often make the added expense worthwhile, even when not required by law.

Upgrade cooling towers. Large savings are possible when cooling towers are retrofitted with new fill, efficient transmissions, high-efficiency motors, and variable-frequency drives. Good water chemistry is needed to minimize the use of environmentally hazardous chemical biocides. Ozone treatments also may be useful.

Chillers have changed dramatically in recent years. Today's models are far better for the environment than older products. Photo: McQuay Air Conditioning

Interconnect mechanical rooms for greater modularity and redundancy. This increases effective capacity while improving part-load efficiency.

IMPORTANCE OF MAINTENANCE

Proper maintenance helps prevent loss of HVAC air balance (return, supply, and outdoor air); indoor air quality problems; improper refrigerant charge; fouling of evaporator coils by dust and debris; poor water quality in cooling towers; and water damage from condensate.

Provide a monitoring and diagnostic capability. An important part of maintaining the rated efficiency of equipment and optimal performance of HVAC systems is understanding how they are functioning. Incorporate systems to track performance and identify problems quickly when they occur.

Ensure that air handlers are maintained. To achieve better indoor air quality and reduce operating costs, steam-clean evaporator coils and air handlers at a minimum three-year rotation. Also service filters frequently.

Service the ventilation system. A good balance report is required. Airflows can then be periodically checked. Periodically lubricate dampers and check their operation by exercising the controls.

Prevent or repair air distribution system leakage. In residential and small commercial buildings, air duct leakage can be a huge energy waster. Leaks can also cause comfort and air quality problems. Check ventilation rates after duct repair to ensure that ASHRAE standards are met and that desired pressure relationships are maintained.

Eliminate or upgrade inefficient steam systems. Leaks are a common problem with older central steam distribution systems. Regularly inspect for evidence of leaks; repair problems as they occur or upgrade the system.

Check for improper refrigerant charge. Refrigerant-based HVAC systems require precise levels of refrigerant to operate at peak capacity and efficiency, and to most effectively control interior humidity in moist climates. Loss of refrigerant charge not only wastes money but also damages the environment—most refrigerants deplete stratospheric ozone. Inspect for leaks and promptly fix problems. Consider replacing older equipment with new, more efficient, ozone-safe systems.

Provide or consider ease of maintenance when making any HVAC system modifications or equipment purchases. Make sure that access to filters (for cleaning or replacement), ducts (for inspection and cleaning), controls, and other system components remains easy. Label components that will need servicing, and post any necessary inspection and maintenance instructions clearly for maintenance personnel.

References

ASHRAE Standard 62 (ventilation), *Standard 90.1* (energy performance), others; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Atlanta, GA; www.ashrae.org.

A Design Guide for Energy-Efficient Research Laboratories, Lawrence Berkeley National Laboratory; available online (also downloadable) at ateam.lbl.gov/Design-Guide.

Space Heating Technology Atlas (1996) and *Commercial Space Cooling and Air Handling Technology Atlas* (1997), E Source, Inc., Boulder, CO; (303) 440-8500; www.esource.com.

Contacts

HVAC retrofits and maintenance opportunities are thoroughly covered in the FEMP-sponsored "Trained Energy Manager" course. Contact the FEMP Help Desk at (800) DOE-EREC (363-3732) for course information.

Information about the Laboratories for the 21st Century project is online at www.epa.gov/labs21century/.

For written material and software to assist with evaluating HVAC systems, contact the EPA ENERGY STAR® Building Hotline, (202) 775-6650; www.energystar.gov.