HVAC Systems

National Park Service
U.S. Department of the Interior

Environmental
Leadership Program

These air quality comparison images illustrate decreased visibility from pollutants at Mammoth Cave National Park in Kentucky. Visibility on August 6, 2005 (inset), is 16 miles. Visibility on September 30, 2005, is 109 miles. Air quality is compromised from acid rain, sulfur, ozone, and nitrogen emissions.

Smart Comfort

Indoor environments and air quality are just as important to park staff and visitors as the outdoors. Keeping people comfortable, procuring energy-efficient equipment, and using renewable energy sources reduces operating costs and lessens environmental impacts from energy consumption in our national parks.

Environmentally responsible heating, ventilating, and air conditioning (HVAC) systems help protect park resources by conserving energy and reducing atmospheric pollutants. By developing efficient and cost-effective HVAC applications, the National Park Service will ensure successful stewardship of our most important natural and cultural resources for the future.

Historic structures have special HVAC requirements.

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Zion National Park

Zion Canyon Visitor Center incorporates an open floor plan, local natural elements, and energy-efficient concepts into an attractive design that saves energy and operating expenses while protecting the environment.

Clerestory windows provide illumination and air circulation. The high windows allow natural ventilation and are sized to allow sufficient winter sunlight to help heat the building (passive solar heating). Overhangs shade the glass from the hot summer sun, while a tree canopy also minimizes heat gain on warm summer afternoons.

When natural ventilation proves inadequate, evaporative cooling towers help reduce indoor temperatures. Water sprayed on pads at the top of the towers evaporates, cooling the surrounding air. The chilled, dense air gravitates through the tower and exits through large openings below, where it can be directed into the building, onto the patio, or both.

A south-facing Trombe wall helps heat the building. Solar heat is trapped between a pane of glass and a black selective coating that has been applied to a stone wall. The masonry wall stores the heat for release into the building later in the day, providing energy-efficient radiant comfort to park visitors and staff. When clouds obscure the sun, radiant ceiling panels provide heat. A roof made of structural insulated panels (tighter than standard frame construction insulation systems) extends energy efficiency.

HVAC Facts

People not only enjoy outdoor experiences at national parks, they also receive enriching experiences indoors at visitor centers and educational facilities. As a result, indoor environments and air quality are important considerations for park management.

The environmental impacts of keeping national park buildings comfortable and open year round are both significant and unseen. The Energy Information Administration estimates that it takes as much energy as 36 million tons of coal or about 260 pounds of coal per person each year, to heat, cool, and ventilate buildings in the United States. The proportions of energy and maintenance costs consumed by various mechanical heating, ventilation, and air conditioning (HVAC) components vary according to system design and climate. Such systems typically account for about 25 percent of building energy use, exceeded only by lighting in most cases.

Providing key services, especially in remote park locations, consumes non-renewable fossil fuels and releases combustion byproducts to the atmosphere. Such pollutants contribute to acid rain, smog, and global warming—all significant threats to park resources. Maintaining services and systems in an environmentally responsible way demonstrates that the National Park Service is a good steward of the resources the agency has been entrusted to protect.

In this manner, parks also provide examples for people to follow in their daily lives, such as ensuring that heating and cooling systems are on only when needed—the most cost effective way to save energy and money.

Find Out More

- American Society of Heating, Refrigerating and Air Conditioning Engineers: www.ashrae.org
- Energy Efficiency and Renewable Energy program, U.S. Department of Energy: www.eere.energy.gov
- Energy & Environmental Building Association's Consumer Resources: www.eeba.org/resources/consumer/new/hvac_general.htm
- Energy Star: www.energystar.gov
- Greening of the Interior: www.doi.gov/greening/energy
- Green Seal: www.greenseal.org
- Indoor Air Quality Association: www.iaqa.org

Operation Conservation

Attention to energy efficiency during operation and maintenance of existing HVAC systems remains the simplest way to reduce operating costs and impacts on the environment. Follow this list of action items for proper maintenance while planning for new system requirements.

Simple Steps First
Identify low-cost or no-cost system modifications. Using programmable thermostats enables HVAC systems to match building use more closely and helps reduce energy consumption. Check or enable automated setback capabilities for best results. In addition, use natural ventilation where possible to increase occupant comfort.

Control HVAC loads with blinds, window shades, and other traditional methods. These devices help lessen heating or cooling needs. Ensure that windows and doors are closed during heating or cooling operations to alleviate system imbalances (such as an open window near a thermostat).

Focus on Occupants
Effective HVAC control systems rely on sensors instead of direct occupant feedback to maintain uniform temperature and healthy air quality within a prescribed "comfort zone." Focusing on providing a comfortable indoor environment can help reduce complaints and may reduce energy use. This approach can also help to identify any problems within the system.

Routine Maintenance
Common problems with equipment and controls can increase a building's energy consumption by about 15 to 30 percent. Complications can often be eliminated by better maintenance and inspection practices.

Ventilation
Inspect and maintain filters. One of the simplest and most effective methods of increasing an HVAC system's efficiency is to inspect and clean or replace system air filters on a regular basis. This increases airflow through the system, resulting in improved system efficiency, better indoor air-quality, and increased occupant satisfaction.

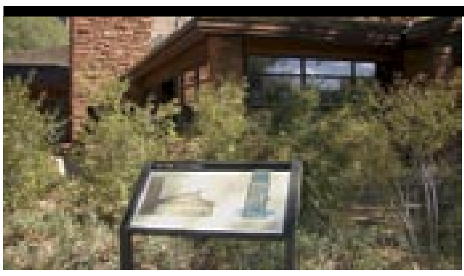
Seal and test ducts. Leaky ducts can account for 25 to 30 percent of the energy losses in HVAC systems. Implement a systematic and regular inspection and maintenance program to locate and fix ducts throughout buildings and systems (especially in older buildings).

Heating and Cooling
Keep things warm longer. Insulation on ducts, hot water lines (even chilled water pipes and fittings), and building shells should be repaired or added where missing. Tightly sealed windows and doors with good insulation value are also important. Consider alternatives such as geothermal systems or heat pumps that draw heat from the ground or outdoor air in winter and reverse the process for cooling in summer.

Reliable and efficient operation of chilled water systems used for cooling depends on the condition of passages within the chiller and piping system. Regular maintenance of water in a system can require using additional water and chemicals, and should include steps to conserve water and reduce the use of chemical pollutants. Minimize excess blowdowns (the amount of water sent down a drain or sewer) and use makeup water (water feed needed to replace that lost by evaporation or leakage in a closed-circuit operation) only as needed.

Looking Forward
Selection of new HVAC systems and building designs has important and long-term financial and environmental effects. Even though the process requires much time and attention to detail, these basic considerations can lead to successful system design:

Design for comfort. When retrofitting or planning a new building, close attention to the use of natural features, skylights, ventilation, landscaping, insulation, and other energy-recovery equipment can improve long-term operational efficiency. Exercise power options. If measures have already been implemented to improve the operational efficiency of a facility, consider taking the next step—choose renewable energy available through a utility, or install photovoltaic panels to collect solar energy.



Exhibits help people understand building designs.

Energy use is linked to occupant comfort.