



Designing the Ideal Healthcare Environment

Our country's aging population will have increasingly demanding healthcare needs in the coming decades, and healthcare organizations are preparing for the onslaught. Rapidly developing technologies and environmental policies are enabling and helping to define new modern standards for healthcare facilities. Many groups – from the smallest doctor's offices to the most complex hospitals – are responding with new construction, expansion and renovation of their facilities to meet the looming need.

The blueprint for healthcare facilities includes a laundry list of quality expectations: precise environmental quality, cost-effectiveness, efficient operations and ease of maintenance. HVAC technologies have a direct and significant impact in all of these areas and are helping organizations meet their goals.

Precise Environmental Quality

A hospital is a complex facility of interrelated functions that must accommodate the constant movement of people, equipment and supplies throughout its structure. And yet each sub-environment within the overall structure has a precise standard for air quality and control that must be maintained through a delicate balance of ventilation, temperature, humidity, filtration, air pressure and velocity. Each subsection of the hospital is driven by patient comfort, staff working conditions and/or disease management parameters.

Indoor environmental quality affects all aspects of a hospital. HVAC systems – heating, ventilation and air-conditioning – directly affect working conditions, well-being, safety and health of the medical personnel and patients in these environments.

The variables for setting up an effective HVAC system for a hospital are wide ranging. Air-pressure relationships must be maintained in all operating conditions. Facility managers must consider the varying needs for public areas, sterile rooms, soiled-laundry rooms, operating rooms, intensive care units, immuno-suppressed patient floors, and neonatal care units, to name a few.

In addition, there are many biological and chemical contaminants present in various areas of a hospital that have the potential to compromise the safety of patients and staff members in the rest of the building. The HVAC system is a critical factor for keeping contaminants contained.

For new or renovated facilities, hospital designers and HVAC engineers must construct a system that protects the positive pressure of operating rooms, intensive-care units, nurseries, and protective-environment rooms. Building systems must keep many other environments at a negative pressure for airborne-infection-isolation. In addition, there are special ventilation requirements for autopsy, sterilization, and soiled-laundry rooms, which need to have all air exhausted to the outdoors.

Managing space airflow helps hospitals control the spread of infections. About 80 to 90 percent of bacterial contamination found in a wound comes from ambient air. Operating room air contains skin squames, lint particles, respiratory droplets, aerosols and waste medical gases used for anesthesia.

Proper ventilation and frequent air changes remain the primary objective for securing a safe and healthy indoor operating room environment. It helps reduce bacteria, viruses and dust concentration to acceptable levels. It removes

anesthetic gases and odors. And it generally provides a comfortable working environment for the staff performing operations.

Efficient filters can remove nearly all bacteria present in a hospital. HVAC systems also play a primary role in temperature and humidity control, factors critical to maintaining consistent comfort in therapeutic environments. For example, nursery-suite temperatures typically are maintained between 70°F and 75°F, in accordance with ANSI/ASHRAE/ASHE Standard 170-2008, while the temperature in operating rooms may need to be kept as low as 68°F. The relative humidity in many spaces must be maintained between 30 and 60 percent, while burn-patient treatment rooms sometimes are maintained with a relative humidity between 40 and 60 percent.

As with any modern structure, it is important that hospitals and other healthcare facilities are built with a tight zone envelope, so that simultaneously they can be efficient and protective of uncontrolled air that could enter from other spaces.

Achieving Efficiency and Sustainability

Governments, energy advocates and consumers are challenging healthcare organizations to reduce energy consumption significantly, eliminate emissions and become more sustainable. Economic pressures also are forcing hospital facility managers to cut energy costs, even as electricity and gas rates often increase year over year.

However, hospitals are 24/7 facilities that consume a great amount of energy to meet heating, cooling, humidity and ventilation requirements. HVAC systems in these facilities transport a huge amount of air compared with systems in typical buildings of comparable size.

Keeping this in mind, HVAC can improve the overall energy efficiency of facility operations. New efficient options are available on all types of HVAC equipment. They're also becoming increasingly affordable, especially when factoring in the lifetime savings.

Energy conservation systems and controls can reduce energy consumption without sacrificing quality of services and comfort. Energy efficient design and operation of the mechanical systems can allow for continuous operation of systems in support of operating rooms and other working areas. Here are some design guidelines to drive energy efficiency:

- **Energy analysis software** allows engineers to create an accurate model of almost any building. Engineers can estimate energy use and analyze potential savings. The software is useful to decide what equipment might be appropriate for different sections of the hospital.
- **Good control systems and strategies** improve energy efficiency. There are various control strategies that reduce energy use at part load and minimize system fighting (reheat).
- **Air handling units dedicated to the operating rooms.** Each operating room should be provided with one thermostat and humidistat for precise temperature and humidity control. This gives hospital staff the ability to set temperature and humidity to the setting that is most appropriate for each procedure.

- **Building management systems** provide the most comprehensive means to control targeted areas. These are more elaborate systems and are justifiable for large-sized, multi-disciplinary facilities, especially when combined with other hospital controls.
- **Mechanical design concepts** can improve energy efficiency. For example, properly controlled variable air volume systems can be used to reduce the air rates during unoccupied time in operating rooms and other areas. Sensible heat recovery can be accomplished using a coil loop or plate heat exchanger in the air handling unit. Heat recovery from the chiller plant can reduce reheat energy associated with the high minimum air change requirements.
- **Proper HVAC insulation** can reduce the cost of operating the HVAC system. The primary functions of HVAC insulation are to reduce component heat transfer and thereby improve system efficiency. Duct wraps should be applied to the exterior of sheet-metal ducts and can be made of a variety of materials, including fiberglass, cotton, and foams. Wraps commonly are used in hospital applications, especially with systems carrying cold air.
- **Focusing on the entire building envelope** – roof, walls, windows, doors, floors – is critical when you are looking to create a high performing, energy efficient building. And the type of lighting equipment used can also drive significant energy savings.

- **Service and maintenance programs** for building systems will keep equipment running in top condition, allowing the hospital to maximize its equipment investment in addition to sustaining the initial energy savings, both of which help pay back the initial investment.

Energy conservation can be a never ending battle, with a combination of continuous assessment and new technologies, hospitals can set reasonable goals and energy targets that can be achieved in the long term. And energy savings give healthcare organizations the ability to invest in other priorities and improve medical services.

Operations and Maintenance Go Hand-in-hand

A sound HVAC system doesn't stop at the installation. Facilities staff must be properly trained in all aspects of the building systems – monitoring, operation, and maintenance. Given the strict requirements for each of the specialized treatment areas in the hospital, the system is only as good as its maintenance.

Dust and moisture can accumulate and provide a place for microorganisms to grow and become a source of infection. Regular inspection and maintenance can detect potential problems and prevent potentially serious damage. All ductwork and equipment must be regularly maintained. HVAC systems should be built for accessibility to inspect and clean, and all maintenance personnel should have easy access to all components.

Sensors and control systems must also be regularly inspected; random checks are insufficient. There should be a specific plan to calibrate sensors for continued accurate airflow,

pressure, humidity and temperature control.

It is critical for facilities staff to keep updated on new technical information and system upgrades. A service file for all equipment must be kept current and readily available for proper operation, inspections and servicing.

With proper HVAC installations and ongoing maintenance, hospitals can ensure optimal environments for healthcare and uninterrupted services.



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