Evaluate and implement operating room airflow setback.

All ECM content was independently developed and reviewed to be vendor-, product-, and service provider-neutral.

Description

Operating room HVAC systems use a significant amount of energy delivering and conditioning air when an operating room is occupied. Setting back the system when the room is not in use reduces energy consumption but will require significant coordination with clinical staff.

Project Talking Points

- A typical operating room delivers 20-25 air changes per hour (ACH) in occupied mode with 4 ACH of outside air, and many older designs have air changes in excess of 30 ACH.
- ASHRAE 170 requires operating rooms to have a minimum of 20 air changes per hour. ASHRAE 170 and many state codes also allow the number of air changes to be reduced "when the space is unoccupied providing that the required pressure relationship to adjoining spaces is maintained while the space is unoccupied and that the minimum number of air changes indicated is reestablished anytime the space becomes occupied" (7.1-Subsection 1.c).
- A typical operating room HVAC system cools room air to as low as 52° F and then reheats the air back to room temperature, an energy-intensive activity. Humidity control can be energy-intensive as well, so reducing the volume of air treated will reduce energy consumption.
- Depending on the pattern of use of an operating room, which may be unoccupied 40 percent or more of the time, HVAC setbacks represent a significant opportunity to save on energy use.
- OR setbacks are not an "all or nothing" change. There are different levels of setbacks and control based on facility tolerance and end-user preference.

Triple Bottom Line Benefits

- Cost benefits: Reduced heating and cooling results in direct operating cost benefits. Savings will vary depending on local climate, number of operating rooms, and operating room usage patterns.
- Environmental benefits: Setting back HVAC system settings reduces energy use and emissions associated with operating the facility's HVAC system.

- Social benefits: Reductions in hospital operating costs provide for a more sustainable health care system and help reduce the costs to consumers.

Commissioning Connections

- ASHE (www.ashe.org)
    - *Health Facility Commissioning Guidelines*
    - *Health Facility Commissioning Handbook*

How-To

1. Start by reading the ASHE monograph Operating Room HVAC Setback Strategies, which provides a good primer for getting started with this strategy.
2. Involve all affected users early in the process including: surgeons, clinicians, infection control staff, facility staff and operators, owners, and any trusted external contractors with intimate knowledge of the existing systems. It is critical to understand any perceptual barriers as well as preferences for how the upgraded system will respond to and interact with users.
3. Your facility engineer, a trusted third-party engineer, or a trusted contractor with intimate knowledge of your existing HVAC system is your best resource for implementing this strategy as the level of complexity will vary according to the age of the system, the type of system, and its existing controls. It is recommended that you enlist the assistance of a trusted third-party engineer to evaluate the existing system and recommend an appropriate solution. Multiple vendors offer a range of solutions, and it can be difficult to evaluate solutions with respect to what best suits your system, budget, and user preferences.
4. Coordinate with the facility's infection control officer on the allowed minimum turndown rates and zone temperature ranges. The minimum air flow rate to maintain a sterile environment may be higher than the air flow rate to maintain pressurization. Coordinate setbacks with testing procedures to determine if there is an increased buildup of dust or debris on surfaces when air changes are reduced. Consider a staged approach by reducing air flow gradually over time to find the HVAC system's sweet spot for energy savings and infection control.
5. Establish a baseline energy consumption level for your facility's operating rooms that accounts for fan, cooling, humidification/dehumidification, and reheat energy during normal operating hours. Adding a virtual point to the BAS, calculating OR suite kW (or other KPIs) is a great method to track progress.
6. Identify additional key performance indicators such as user satisfaction, code compliance, and efficiency.
7. Understand how your HVAC system currently operates. Specifically:
    - How are the operating rooms controlled and monitored?

- How is the pressure differential maintained for the operating rooms?
- What is the condition of the existing HVAC system serving the operating rooms – dampers, ductwork, controls, and so on? You may have the opportunity to discover and address other opportunities to make the existing system more efficient.
- What is the air leakage in the existing operating rooms? This rate will affect how much supply air will be required relative to return air to maintain a positive pressure differential.
- How many and which air-handling units serve which spaces? Does the air-handling unit that serves the operating room(s) also serve any non-operating room spaces? Excessive reheat could be occurring in the non-operating rooms as operating rooms often require a much lower temperature.
- The humidity in operating rooms must always be maintained between 20 and 60 percent. How does your system maintain this level?

8. Once you understand your current control system, you're ready to assess the options for a control strategy that can reduce air changes while maintaining appropriate pressure relationships. Operating room setback is more complicated than setback for other types of spaces because the ORs must maintain positive pressure relative to all adjacent spaces whether they are occupied or unoccupied. Humidity levels must be maintained, as well. Ventilation and humidity in operating rooms can be controlled in a number of ways, and these options need to be well understood before a setback methodology is designed.
    - Pressure relationships can be maintained using two-position VAV boxes on the supply and return air ducts; pressure independent valves on the supply and returns; or a modulating control damper on the return duct.
    - Identify codes that may restrict the minimum number of air changes during setback (e.g., California). Verify the minimums required by local codes.
    - Simplify controls by modulating airflow only. Although some facilities may allow humidity and temperature to vary during HVAC setback, it is generally preferable to reduce only the airflow, while maintaining temperature and humidity. With this strategy, an operating room can achieve ready mode extremely quickly.

Following is a list of user interface options that may be employed:

1. Time schedule – this method is good for non-emergency operating rooms that operate on a predictable schedule, like ambulatory ORs. It requires an override in case of unforeseen complications, like a surgery going long
2. Occupancy sensors -these can combine audio, infrared, and motion detection. Try to implement a "walkthrough mode", so cleaning staff and other personnel walking through while unoccupied won't accidentally shift the system into occupied mode.
3. Manual switchover-these require staff training and open the possibilities for human error.

4. Combined interface/control methods (e.g., time schedule with occupancy sensors and manual override for unscheduled events).
5. Integration of medical information system for patient and procedure tracking into building automation system (BAS).
6. Set up a system to track key performance indicators.

Tools

If you have an ROI tool, calculator, or similar resources to share, please contact us or participate in the discussion tool at the bottom of this page.

Case Studies

Do you have a case study to share? Please contact us.

The following examples are in-progress implementations of OR setback that have not yet been formalized, evaluated and written as a case study. However, they provided practical examples of how OR setback can be utilized.

Example 1

A new hospital has 14 orthopedic operating rooms (OR) that operate at 20 ACH (4 ACH outside air) 24 hours per day, seven days per week. The hospital is primarily for scheduled procedures such as total joint replacements; however an occasional accident victim may be admitted for emergency procedures.

The hospital will initially operate all 14 OR's until operational baselines (patient census, infection control, etc.) can be established. Approximately six months after commissioning, the staff will reduce air change rates during unoccupied hours and measure relevant infection control metrics over time as air change rates are reduced.

A variable air volume HVAC system has been designed to operate with a minimum turndown of 5 ACH to maintain pressurization.

Based on the patient census and operational experience a decision will be made the hospital staff on how many OR's may be setback over night.

The control of the OR setback is based on data relayed by the medical information system (MIS). When a surgery is scheduled, the information is relayed to the BAS, which ramps up the air handling unit to 20 air changes per hour. Once the surgery is complete, the room is set as unoccupied in the MIS, which then relays that information to the BAS to setback the air flow rate. In addition to the air flow, the lights are shut off during unoccupied times.

Example 2

A new hospital addition includes four c-section operating rooms (OR) as part of a new birthing center than includes labor and delivery patient rooms, post partum patients rooms and support spaces. The c-section OR's operate at 20 air changes per hour (ACH) with 4 ACH of outside air in a facility that operates 24 hours per day.

A complex setback strategy is being implemented that utilizes inputs from the medical information system (MIS), which relays information to the building automation system (BAS) which controls the air handling unit (AHU). The AHU is setup to reduce the air flow rate from 20 ACH to 5 ACH (required to maintain pressurization). The actual setback air change rate will be determined experimentally over time. The building operators will coordinate with the infection control staff to determine a viable minimum air flow rate. In addition to setting back the air flow rate, the lights in the OR are shut off based on a signal from the BAS. Temperature is not setback as temperature has the longest lag time to meet the desired set point.

C-sections are procedures that are sometimes scheduled, and sometimes unscheduled, which requires rapid reaction on the part of the HVAC system. This is somewhat impractical in this setting as it can take several minutes for a room to reach operating requirements. To allow for unscheduled c-sections, a strategy of having 1 OR always on standby was selected.

The first OR is always operating at 20 ACH even when unoccupied. Once that OR becomes occupied based on a signal from the BAS, the second OR is brought up to operating conditions. This continues with the third and fourth OR's as the OR's are occupied.

Regulations, Codes and Standards, Policies

Section 7.4.1 of ANSI/ASHRAE/ASHE Standard 170-2013: *Ventilation of Health Care Facilities* requires that: "Operating rooms shall be maintained at a positive pressure with respect to all adjoining spaces at all times. A pressure differential shall be maintained at a value of at least +0.01 in. wc (2.5 Pa)."

This requirement applies during both occupied and unoccupied modes. However, per Section 7.1 of Standard 170-2013:

"For spaces that require a positive or negative pressure relationship, the number of air changes can be reduced when the space is unoccupied, provided that the required pressure relationship to adjoining spaces is maintained while the space is unoccupied and that the minimum number of air changes indicated is reestablished anytime the space becomes occupied. Air change rates in excess of the minimum values are expected in some cases in order to maintain room temperature and humidity conditions based upon the space cooling or heating load."

Cross References: ASHRAE

- Advanced Energy Design Guide for Large Hospitals: 50% Energy Savings

ECM Synergies

- Establish a baseline for current energy consumption.
- Retrocommission HVAC controls.
- Install variable frequency drives on pumps and motors.
- Evaluate setback of temperature and airflow settings at night.

More Resources

- American Society of Heating, Refrigerating & Air-Conditioning Engineers (ASHRAE)
    - Guideline 14: Measurement of Energy and Demand Savings

Energy

Level: Advanced

Category List:

- ENERGY
- HVAC
- Operations

ECM Attributes:

- Optimize Operations
- Repair or Optimize Existing Systems (fix what you have)
- System Upgrades