Keeping Air Pressure in Control

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LEARNING OBJECTIVES

1. Identify the rooms that require air pressure controls within healthcare
2. List the components within the air management system
3. Define air management needs of Sterile Processing departments
4. Identify controls that manage air pressure

Anyone downwind from a skunk can appreciate the importance of air flow. Avoiding the unique stench of North America's favorite black-and-white critter means knowing where the skunk is and the direction of the wind. Healthcare facilities do not have to worry about skunks, but they do need to worry about other hazardous airborne elements. Controlling the spread of airborne contaminants relies on knowing where the contaminants are and how to manage air flow. Air management is a critical factor of safety within healthcare facilities.

Objective 1: Identify the Rooms That Require Air Pressure Controls Within Healthcare

Air management prevents infectious agents—like bacteria and viruses—from traveling in the air currents to a susceptible person. Dust, microscopic droplets, and aerosolized fluids create an opportunity to suspend microorganisms in the air. Once airborne, they will travel anywhere the air takes them. Hospitals prevent their spread by controlling the direction air is flowing.

The first type of air flow management is positive pressure. It prevents microorganisms from entering the room. Positive pressure creates a constant flow of air from inside the room to outside the room, which prevents contaminants from the adjacent rooms and hallways from entering. There are many rooms in the hospital that need positive pressure to keep microbes away from patients. Operating rooms, delivery rooms and intensive care units are a few examples. Sterile Processing departments (SPDs) use positive pressure to keep microbes away from clean and sterile medical devices. Assembly, sterilization and sterile storage all require positive pressure.

The second type of air flow prevents microorganisms from leaving the room. Negative pressure is created by removing air from the room while supplying more air to the rooms and hallways adjacent to it, which creates negative air pressure within the room. The air flows from the adjacent areas into the room, preventing microbes from escaping. Many rooms require negative pressure, including airborne infection isolation rooms, waiting rooms, soiled linen or

trash rooms, and autopsy rooms. SPDs use negative pressure to keep aerosolized materials, droplets and other airborne contaminants of the decontamination and soiled device holding areas from escaping to adjacent rooms and hallways.

Objective 2: List Components Within the Air Management System

Air pressure management is one component of the overall air management process. Air management controls temperature, humidity, microbial and particulate load, and relative pressures of each room in the hospital. Additionally, air management works on improving air quality through several controls, one of which is by mixing fresh air from the outside.

Air supplied to the Sterile Processing (SP) areas begins at the hospital's air management system. External vents draw air into the building where it passes through low- to medium-efficiency filters. These filters remove large particles of dirt and dust from the air. The filtered air travels through the ducts to the conditioner. The conditioner heats or cools the air as needed and adds humidity. Any air returning from the hospital mixes with fresh air during conditioning.

Conditioned air continues to the second bank of filters. The second bank of high-efficiency filters removes fine dust, pollen and some bacteria from the conditioned air. It does not remove viruses, all bacteria or fungal spores; however, it does make the air safe for most applications in the hospital.

Rooms where patients are highly susceptible to infection get a third filtration: high-efficiency particulate air (HEPA) filtration. HEPA filters placed in the ducts that directly supply air to the room remove particle sizes of 0.3 microns or larger (that size is smaller than bacteria and spores). HEPA-filtered rooms stay at positive pressure, thereby preventing contaminant invasion from the neighboring rooms and hallways. HEPA filtration is not a requirement of air supplied to the SPD; however, HEPA-filtered air may be a requirement for air used during processing of instruments.

The final part of the air management system is the return air. New air continuously enters the room. As it does, the old room air leaves. Return ducts allow the older air to move out of the room toward the air management system. Some air leaves the facility while a part of this air returns to the conditioning unit, mixing with the incoming fresh air. Changing the air within the room removes contaminated air and replaces it with fresh, filtered air. The number of times the entire volume of old air exchanges with fresh air within one hour is the "air changes per hour" (ACH). The required ACH depends on many factors including the room type, bioburden level and threat of airborne microorganisms.

Room air becomes contaminated with microbes, dust, dirt, and droplets expelled by patients, visitors and medical staff. The contaminated air returns through the return ducts to mix with fresh air. Mixing the return and fresh air dilutes the concentration of these contaminants. Filtration through the second bank of filters further reduces contaminants. In most cases, this makes the air suitable for hospital use; however, some rooms have bioburden loads that are too great or an airborne microbial contamination threat like tuberculosis. For these rooms, direct venting of room air to the outside prevents recirculation of the contaminated air. Due to the potentially high bioburden levels, SP decontamination and sterilization equipment rooms require direct external venting.

Hospitals remove microbial threats from the incoming air; however, microbial threats can come through open windows, doors and other natural openings to the outside. Keeping the entire hospital at a positive pressure creates a continuous flow of air through these openings toward the outside. Hospitals create positive pressure using the heating, ventilation and air conditioning (HVAC) system. The HVAC system creates a surplus of air by drawing in more air than the building can hold. The extra air creates positive pressure.

Some may question how negative pressure rooms can exist when the entire facility is positive pressure. The answer is that individual room air pressures are based on the relative pressure difference between them—and not an absolute number. That is to say that the pressure of one room is higher or lower compared to the pressure of the adjacent rooms, but all are positive compared to the outside.

Keeping the individual rooms positive or negative is dependent upon many factors. What follows are just a few such factors:

- The number of openings;
- The size of openings and cracks;
- The material of construction for walls, floors and ceilings; and
- The activity in the room.

HVAC engineers must calculate the maximum volume of air that could potentially leave or enter from these sources and adjust the amount of air sent to or removed from the room to compensate.

Objective 3: Define Air Management Needs of Sterile Processing Departments

Recommendations for air management are similar across several guidance documents. Of these, the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) and the Centers for Disease Control and Prevention are the most recognized. Although temperature and humidity guidance are provided, these numbers are not absolute. SP professionals must

Room/Zone	Temperature	Relative Humidity	Pressure	ACH (Air Changes Per Hour)
Soiled Holding Room	NR	NR	Negative	10 (2 of fresh air)
Decontamination	60-73°F	NR	Negative	6 (2 of fresh air)
Assembly/Sterilization	68-73°F	≤60%	Positive	4 (2 of fresh air)
Sterilizer Equipment Room	NR	NR	Negative	10
Sterile Storage	≤75 °F	≤60%	Positive	4 (2 of fresh air)

Table 1: Decontamination Room Air Management Requirements for Hospitals and Outpatient Spaces, Per ANSI/ASHRAE/ASHE Standard 170 – 2017.

perform a risk assessment to determine what the temperature and humidity should be. Disposable items, chemicals, cleaning chemistries, sterility assurance products, and wraps are just a few of the items within SPDs that have storage condition requirements. Equipment may have temperature and humidity operational requirements. All of these must be listed and considered when establishing room specifications.

In addition to the risk assessment, the age of the facility's HVAC system plays a vital role. It is important to follow the recommendations published for the specific year of the HVAC system's installation, even if those standards have been updated for newer systems.

Pressure is relative and pressure specifications are based on the pressure differentials measured between rooms. There are no recommendation lists that identify exact differential pressures for each of the SP rooms. Instead, a cross-functional risk assessment team must evaluate the specific needs of the facility and set up the pressure differential specifications. Once set up, pressure differentials between rooms must be continuously monitored, and along with actions taken when those specifications are not met. Manometers measure and report the pressure differentials in either pascals (Pa) or inches of water column (WC). These devices serve as monitors and may have limit alarms.

Objective 4: Identify Controls That Manage Air Pressure

Air pressure balancing can be thought of in terms of water balloons. The balloon expands from the water pressure as it enters. A pin hole allows water to escape the balloon. Continuously supplying water from the faucet keeps the balloon inflated even though it is leaking. The more holes, the more water is needed to keep the balloon's shape. If there are too many leaks, the faucet can't keep up, resulting in the balloon not filling. This is how positive pressure balancing works.

Air flow increases to a point that it overcomes all leaks from cracks, ceilings and walls. However, if the air supply can't keep up with the air leaks, the room loses its positive pressure. Negative pressure rooms act in the opposite direction. Negative pressure rooms must continuously remove enough air from the room to compensate for air that is leaking into the room.

Balancing air flow is the job of the HVAC engineer. They calculate the amount of air flow needed to maintain the rooms pressure—positive or negative—based on normal operation. Doors, windows, pass-throughs and equipment that pass through walls into adjacent rooms are all part of this calculation.

Controlling the amount of air that leaks involves both engineering and behavioral processes. The first engineering control is to seal off cracks. Facilities seal windows, door casings, equipment frames, and wall joints

with caulk and sealants to prevent air movement. Doors employ seals like weather stripping that prevent air flow. Air flow and return systems compensate for the remaining leakage.

The second engineering control prevents large air fluctuations. Equipment such as washers that penetrate though walls use doors on each side. Only one door opens at a time, thereby preventing large fluctuations of air between rooms.

Such engineering controls are not always available. Some facilities use rack returns or pass-through windows with a single door. Other facilities have a door through which personnel can travel. Facilities must rely on process controls to support room pressure. HVAC systems can compensate for windows and doors being open all the time, but that would create a work wind tunnel. Instead, restrictions and limits are established based on the system's capability to compensate for short-lived fluctuations from door openings. Policies and procedures establish when doors can be used, how long rack return doors and pass-through windows can be open, and in some cases, how far a pass-through window can be opened. It is important that limitations are identified, staff are trained, and procedures are enforced when it comes to these processes.

Conclusion

Air management is a crucial function of infection control and prevention because it helps control cross contamination and disease transmission. Facilities must establish engineering controls and processes, and monitor rooms to ensure that air flows in the correct direction. C

RESOURCES

1. ASHE Room Pressurization www.ashe.org/compliance/ec_02_05_01/01/roompressurization
2. FGI requirements for sterile processing facilities. Designing facilities that support the workflow necessary for safe sterile processing. Health Facilities Management ASHE, April 18, 2019.
3. Indoor air quality in hospitals. July 14, 2015. accessed www.csemag.com/articles/indoor-air-quality-in-hospitals/ Consulting – Specifying engineer
4. Centers for Disease Control and Prevention. Guidelines for environmental infection control in health-care facilities: Recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC). MMWR 2003; 52 (No. RR-10): 1–48. www.cdc.gov/infectioncontrol/pdf/guidelines/environmental-guidelines-P.pdf

CHL Self-Study Lesson Plan Quiz - Keeping Air Pressure in Control

Lesson No. CHL 385 (Supervisory Continuing Education - SCE) • Lesson expires May 2024

1. Which of the following can help bacteria and viruses travel on air currents?
   a. Animal saliva
   b. Aerosolized fluids
   c. Food
   d. Human hands

2. Which type of pressure prevents microorganisms from escaping from a room?
   a. Negative pressure
   b. Neutral pressure
   c. Positive pressure
   d. Water pressure

3. Which type of room requires positive pressure?
   a. Decontamination room
   b. Soiled linen room
   c. Autopsy room
   d. Sterile storage

4. What does the first filter do to external air?
   a. Heats the air
   b. Humidifies the air
   c. Removes bacteria and viruses
   d. Removes large particles of dirt and dust

5. What does the conditioner do to the air?
   a. Sanitizes the air
   b. Heats or cools and humidifies the air
   c. Adds a fresh scent to the air
   d. Filters bacteria and viruses from the air

6. Which Sterile Processing areas require HEPA-filtered air?
   a. Decontamination
   b. Assembly and Sterilization
   c. Sterile Storage
   d. None of the above

7. Why is air removed and replaced from rooms?
   a. To maintain a constant temperature
   b. To reduce humidity
   c. To reduce contamination
   d. All the above

8. What happens to return air from rooms with high bioburden, such as decontamination?
   a. All the air is filtered and reused
   b. Some of the air is filtered and reused
   c. None of the air is reused
   d. All the air is sterilized and vented

9. Every room in the hospital is at a positive pressure when compared to outside the hospital.
   a. True
   b. False

10. What affects the ability to support positive pressure?
    a. The number of room openings
    b. The ceiling's construction material
    c. The activity in the room
    d. All the above

11. Which standard or organization defines air management requirements for hospitals?
    a. ANSI/AAMI ST79
    b. ANSI/ASHRAE/ASH Standard 170-2017
    c. Centers for Medicare & Medicaid Services
    d. None of the above

12. What is considered when performing a risk assessment for the Sterile Processing department?
    a. The number of patients in the room
    b. The weather outside
    c. Storage conditions of items used or stored in the room
    d. Water quality

13. What does a manometer measure?
    a. Pressure differentials between rooms
    b. Humidity
    c. Temperature
    d. Particulate levels

14. Which engineering control stops air leaks?
    a. Caulks and sealants
    b. Double-door equipment
    c. Manometers
    d. Controlled access

15. Which of the following helps control large fluctuations in air flow?
    a. Caulks and sealants
    b. Manometers
    c. Rack return
    d. Decreasing air pressure