DESIGN CONSIDERATIONS - OPERATING ROOM

v101

ANTEC controls

The following are considerations when designing a compounding pharmacy. The items listed below help scope out project requirements and provide guidance on designing based on the specific needs.

What is the intended daily use of this operating room (OR)?

The first step in operating room design is to understand how the end user plans to use the space. Several different types of operating rooms exist, each with their own needs for equipment and environmental controls.

Is there specialized equipment to consider?

Surgery spaces may require specialized equipment including, but not limited to:

- Boom lighting
- Medical gas and/or gas vacuums
- Imaging equipment
- Anesthesia equipment

This equipment can produce large amounts of heat that must be included in thermal load calculations.

Is this OR in constant use?

According to Chapter 8 in the ASHRAE Applications Handbook (2011) operating rooms are typically in use 8-12 hours per day. Notable exceptions are trauma centers and emergency departments which are typically in use 24 hours per day. If the OR is only in use for a portion of the day, the room may need to be capable of setback for cost and energy savings.

Is this OR used by multiple surgeons or for multiple surgery types?

Each surgical team and surgery type may have different temperature and/or humidity requirements for the room. If the room has multiple uses, the design engineer must ensure that there is a means to adjust the room setpoints.

What is the minimum ventilation rate?

ASHRAE 170 Table 7.1 states that general operating rooms require 20 air changes per hour (ACH). For the calculation of ACH, ASHRAE 170 section 7.1.a.3 states:

> *"For design purposes, the minimum number of total air changes indicated shall be either supplied for positive pressure rooms or exhausted for negative pressure rooms".*

Operating rooms are positively pressurized spaces, meaning and ACH is calculated based on the airflow supplied to the space.

Will the room need to be capable of setback?

ASHRAE 170 section 7.1.a.3 allows pressurized spaces like operating rooms to reduce their air change rate in unoccupied hours:

"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."

This means that if the space is positively pressurized, it must remain positively pressurized at all times, even when unoccupied. When in setback mode, the room can typically operate as low as 6-10 ACH. The design engineer must ensure that the air valve turndown ratios do not limit the minimum available flow in the operating room.

The design engineer is responsible for providing a means to activate unoccupied or setback modes. This can be accomplished using occupancy sensors, lighting integration, a building automation schedule or local switches.

What air valve technology should be used?

High accuracy terminals paired with standard speed actuation are the preferred air valve technology in operating rooms as they provide a stable and cost effective solution. High accuracy terminals also have a much lower risk of lint or other airborne particulates interfering with valve control or accuracy compared to standard accuracy terminals. High accuracy terminals should be paired with standard speed actuation in operating rooms to assure that modulation for changes in duct static pressure does not introduce system instability. Venturi valves and standard accuracy terminals can also be considered depending on the application.

When can venturi valves be used in ORs?

Venturi valves, like high accuracy terminals, are capable of achieving accurate and stable airflow control in an operating room. In addition, venturi valves are a maintenance free valve airflow technology and have no risk of contamination from airborne particulates. Venturi valves, while being an acceptable technology, are generally not selected for operating rooms as they will typically operate at a higher pressure drop and have higher sound pressure levels than high accuracy terminals. However, if the airflow system is anticipated to have instability, venturi valves have the capability of responding immediately to changes in duct static pressure without introducing further instability.

When can standard accuracy terminals be used in ORs?

Standard accuracy terminals are only recommended for usage on the supply side of an operating room as they are more susceptible to contamination from airborne particulates and lint than high accuracy terminals or venturi valves. Standard accuracy terminals, like high accuracy terminals, should be paired with standard speed actuation in operating rooms

to ensure that modulation for changes in duct static pressure do not introduce instability in the system.

Is sound a concern?

As operating rooms are high stress environments where communication is critical, sound management is often essential in these spaces. Where required, silencers can be used to mitigate the sound produced by the HVAC system. Refer to Chapter 8 in the ASHRAE Applications Handbook when selecting a silencer:

> *"Acoustical materials should not be used as duct linings unless terminal filters of at least MERV 14 efficiency are installed downstream of linings. Internal insulation or terminal units may be encapsulated with approved materials. Duct mounted sounds traps should be of the packless type or have polyester film linings over acoustic fill".*

When considering sound with respect to valve selection, standard accuracy terminals are generally the quietest, followed by high accuracy terminals, with venturi valves being the loudest of the three technologies.

What room control strategy will be used?

Flow offset control is employed by maintaining a constant volumetric offset between supply and exhaust flow in the space. Pressure control, where the room is controlled to a constant pressure, is also an acceptable control strategy. However, pressure control but should be employed with caution as it can be less stable when responding to changes in system static pressure and introduces the risk of overshoot or undershoot. In addition, door switches should always be installed when implementing pressure control to ensure the room is not over or under pressurized in response to the door being opened.

What is the required room setpoint?

When employing offset control, an offset setpoint between 10 – 20% of maximum flow is acceptable in most cases. The exact offset needed to achieve the required room pressurization will depend on room construction and leakage rates and should be verified during commissioning.

When using pressure control, the room setpoint is a differential pressure value measured between the operating room and an adjacent space. ASHRAE 170 section 7.4.1 states:

> *"[Operating rooms (ORs), operating/surgical cystoscopic rooms, and caesarean delivery 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.w.c."*

This pressure requirement is a minimum. It is common to design operating rooms to a positive pressure in the range of +0.02 in.w.c. to +0.05 in.w.c.

Is pressure monitoring required?

ASHRAE 170 does not clearly state that a pressure monitoring device is required to be installed. However, the Normative Notes for Table 7.1 state that:

> *"If pressure-monitoring device alarms are installed, allowances shall be made to prevent nuisance alarms. Short-term excursions from required pressure relationships shall be allowed while doors are moving or temporarily open. Simple visual methods such as smoke trail, ball-in-tube, or flutterstrip shall be permitted for verification of airflow direction."*

Chapter 8 in the ASHRAE Applications Handbook (2011) does however state:

> *"A differential pressure indicating device should be installed to permit air pressure readings in the rooms."*

It is generally accepted that operating rooms should be fitted with permanently installed pressure monitoring devices that make allowances for temporary deviations from the desired room pressure.

Is additional monitoring required?

In the healthcare environment, monitoring of relative humidity (RH) may be required. ASHRAE 170 Table 7.1 dictates several different spaces where a defined range of RH is required, reference this table to determine whether humidity monitoring will be necessary in the space.

Will dynamic temperature control be required?

According to ASHRAE 170 Table 7.1, a standard operating room should operate between 68°F and 75°F. However according to the ASHRAE Applications Handbook certain specialized cardiac surgeries should be performed at a room temperature as low as 62°F. The handbook goes further to state that these ranges are *not intended to be dynamic control ranges*. This means that where possible, the temperature setpoint in an OR should be set at commissioning time and then held constant.

How will the temperature setpoint be adjusted?

If a small range of temperature control will be afforded to the occupants, this can reside at a thermostat or at a larger display. It should be noted that temperature control is generally slow and the available setpoint range should be limited. Settings for temperature control can be adjusted to provide a faster response, but may become unstable and oscillate when too aggressive.

What supply diffusers and return air grilles will be used in the OR?

As ceiling space in an operating room is limited, the selection of appropriate methods of providing the supply and exhaust airflow becomes critical.

What types of supply diffusers are required in an OR?

ASHRAE standard 170 section 7.4.1.a states that:

> *"The airflow shall be unidirectional, downwards, and the average velocity of the diffuser shall be 25 to 35 cfm/ft^2. The diffusers shall be concentrated to provide an airflow pattern over the patient and surgical team."*

Further, section 7.4.1.b states that:

> *"The coverage area of the primary supply diffuser array shall extend a minimum of 12 in. beyond the footprint of the surgical table on each side."*

These sections essentially call for the use of laminar diffuser arrays. Laminar arrays often extend further past the patient table to ensure that the entirety of the required air change rate can be handled by these laminar diffusers without supplemental diffusers. However, ASHRAE 170 section 7.4.1 states:

> *"Additional supply diffusers shall be permitted within the room, outside of the primary supply diffuser array, to provide additional ventilation to the operating room to achieve the environmental requirements of Table 7.1 that relate to temperature, humidity, or a portion of the require air change rates."*

What types of exhaust grilles are required in an OR?

ASHRAE 170 Section 7.4.1 further states:

> *"The room shall be provided with at least two low sidewall return or exhaust grilles spaced at opposite corners or as far apart as possible."*

Additional exhaust grilles can be provided if required to meet the required exhaust flow rates, but should be spaced as far apart as possible.