

VENTILATION PRIMER FOR HEALTH CARE FACILITIES

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Basics

Ventilation refers to the movement of air. In buildings, air can be used to heat, cool and/or control humidity. Air can also be exhausted to control odors or eliminate build-up of pollutants.

HVAC is short for Heating, Ventilation and Air Conditioning. HVAC systems are nothing more than the tempered (heated or cooled), humidity controlled air that comes into, is recirculated within, or is exhausted from a building.

Large buildings are heated by warm air (through ventilation systems), or either hot water or steam heat (through radiant tubing). These same buildings are cooled using ventilation systems. Air can be exhausted from the building using either a few large or many smaller exhaust fans (usually located on the roof).

Your home can contain many of the same ventilation elements found in large HVAC systems. One exception is outside air. Typically older residential construction allows for the outside (fresh) air to leak into any given space within the home primarily through cracks around doors and windows. However, in a large building, the proportion of interior space to exterior surface is much smaller than in a house so that fresh air must be fed into the building, directly through the HVAC unit(s).

Just like a home furnace (with possible central air conditioning, humidification, dehumidification, and filtration unit(s)), a large building is served by one or more HVAC units. Central HVAC units can be quite large (12 ft. by 10 ft. by 40 ft. long for example). These larger units are usually located on the roof or in a mechanical room/penthouse and allow room for maintenance staff to access the inside and outside of the units.

Many nursing homes and hospitals use smaller units (that don't have humidification, dehumidification, or possibly air conditioning features) that serve a single room. These units (called fan coil units, or PTAC=s for Packaged Through-Wall Air Conditioning units) are usually installed under windows and draw outside air through a grill on the exterior wall and then mix it with air being recirculated from within the room.

Larger central systems allow for humidification/dehumidification, better filtration, better operating efficiency, greater central control, and less maintenance effort. However, larger systems must also address controlling the spread of smoke during a fire which requires automatic fan shut-offs and the use of in-line dampers to close ducts where they intersect fire separation walls. Smaller units offer lower initial costs and greater individual control without the complication of a large central system.

Hoods and Exhaust

Hospitals present a wide range of ventilation needs from toxins that must be contained, and sterile fields required in surgery to isolation considerations. Exhaust hoods in kitchens remove excessive waste heat, grease and humidity. In pharmacies, vertical laminar flow hoods protect staff from exposure to odorless, toxic chemotherapy cytotoxins while horizontal laminar flow hoods provide sterile environments for IV admixtures. And in laboratories, hoods are used to protect staff from potentially infectious biological agents.

Slots found in hoods force higher air flow speeds for a given air flow volume, thereby allowing better capture of particles. Exhaust grills remove objectionable odors and reduce concentrations of ethylene oxide (used in non-steam sterilizers) as well as other potentially harmful agents, such as infectious materials in waste (including regulated medical waste) and excess steam at steam sterilizers or dishwashing machines. Exhaust grills should also be located at most film processors or where high-level disinfectants are used.

Filtration

Studies have shown that 90% efficient filters (as measured by industry standards) remove practically all harmful particles from air delivered to operating rooms. Since air is mechanically recirculated within a hospital and is inevitably mixed between interior spaces, these filters must be used in all HVAC systems in a hospital. There is no consensus in the research literature that higher efficiency (HEPA) filters have any benefit with the exception of TB or bone marrow transplant patient rooms. On the other hand, fan coil or PTAC units do require their own filters, but since they essentially serve only one room, the efficiency of the filters can be reduced.

Room Pressurizations

Areas that must remain “cleaner” than surrounding areas must be kept under a “positive” pressurization, meaning that air flow must be from the “cleaner” area **towards** the adjoining space (through doors or other openings) to reduce the chance of airborne contamination. This is achieved by the HVAC system providing more air into the “cleaner” space than is mechanically removed from that same space. Just like a balloon, a room must release the excess air into surrounding spaces. Operating rooms, sterile processing areas, clean utility rooms, and medication rooms are examples of spaces that must remain “cleaner” than adjoining spaces.

Likewise areas that are “soiled” compared to surrounding areas must be maintained under a “negative” pressurization, meaning that air flow must be to the “soiled” area **from** the adjoining space (through doors or other openings) to help contain odors and contaminants. “Soiled” areas must be served by exhaust, not return (recirculated), ventilation so that contaminants are not recirculated within the building. This is achieved by the HVAC system providing less air into the “soiled” space than is mechanically removed (exhausted). Examples of such rooms include soiled utility rooms, decontamination rooms, janitor closets, and toilet/bathing rooms.

Proper room pressurization can be checked using a smoke stick, cigarette lighter, or smoldering match at doors held open approximately 1/4 inch to visually see which direction air is moving. Care must be taken when checking this to make sure that **the door is not moving** during the test since a door swinging can move more air than the design ventilation differential in the room. It should be an obvious rule of thumb that if you can't detect air movement via this method then no significant, practical pressurization of the room exists.

Isolation Rooms

As health care becomes more sophisticated, so does the need for isolation. Proper ventilation is only one aspect of what health care providers need to do in addressing isolation needs. Immuno-compromised/suppressed patients (chemotherapy, organ transplantation, or AIDS) should be protected and therefore located in positive pressurization spaces. Infectious patients (including TB patients) must be located in negative pressurization rooms in an attempt to control and remove infectious air-borne particles.

Ante-rooms are designed to provide an "air-lock" (no mix of air between corridor and room) between the protected/infectious patient and the common space. The effectiveness of the air lock (anteroom) is questionable with the greatest asset of the anteroom may be in providing for the storage of isolation and nursing supplies as well as handwash facilities.

Laminar Air Flow

Laminar flow systems use perforated ventilation grills across the entire ceiling or side wall at air flow rates significantly greater than normal to force a steady constant stream of air across the entire room, similar to a smooth steady flow out of an open water faucet versus one that splashes as the water comes out of the faucet. Due to particles generated in the air from almost any human activity (walking, changing bedding, etc.) these systems are not.

Research conducted by the National Institute of Health has demonstrated that the high air flow rates associated with laminar air flow systems can actually be detrimental when compared to more standard designs. This is due to the disruption of the thermal plume that naturally develops from the surgical site which keeps airborne contaminants away.

Conclusion

The best ventilation system is the one that runs right. This does not require special features or outrageous costs, but must instead be properly designed (with plenty of capacity), properly maintained, and periodically tested. Your facility engineering department or a ventilation design expert should be consulted with any specific questions.