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## New Ventilation Guidelines For Health Care Facilities

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### Editor's Note

This book, which is the bible for architects designing hospitals in USA, was reviewed in the Oct-Dec 2001 issue of this magazine.

The 2001 edition of the Guidelines for Design and Construction of Hospital and Health Care Facilities<sup>1</sup> provides recommendations for ventilation for health-care facilities. It is revised periodically and published by the American Institute of Architects Academy of Architecture for Health with assistance from the U.S. Department of Health and Human Services. The new edition has notable changes to the ventilation recommendations.

**Table 1** is an excerpt from Table 7.2, Ventilation Requirements for Areas Affecting Patient Care in Hospitals and Outpatient Facilities (of the Guidelines). It summarizes options and changes to the ventilation requirements for selected rooms. The rationale supporting the revisions is described here.

### Ventilation Rate Changes

**Table 1 : Ventilation rate changes for selected rooms**

<b>Location</b>	<b>Air Movement Relationship to Adjacent Area</b>	<b>Minimum Air Changes of Outdoor Air per Hour</b>	<b>Minimum Total Air Changes per Hour</b>
Patient Room	-	2	6 (4)
Labor/Delivery/Recovery	-	2	6 (4)
Labor/Delivery/Recovery/ Postpartum	-	2	6 (4)
Airborne Infection Isolation Room	In	2	12
Emergency – Triage/Waiting	In	2	12
Radiology – Waiting	In	2	12
Procedure	Out	3	15

### **Patient Rooms**

One significant change relates to the ventilation recommendations for patient rooms. The “total” air changes per hour (ACH) for the room has increased from 2 ACH to 6 ACH. (This rate may be reduced to 4 ACH when supplemental heating and/or cooling is incorporated in the HVAC design for the room.)

This change reflects recent research<sup>2</sup> that concluded that 6 ACH and 4 ACH (if baseboard heating is provided) are the minimum ventilation rates required to provide satisfactory patient comfort based on computational fluid dynamic (CFD) modeling analysis. Analysis showed that the previous recommended ventilation rate of 2 ACH resulted in high values of Local Mean Age of Air (LMAA) that would manifest as a “stuffy” room. Furthermore, the previous ventilation rate of 2 ACH was acknowledged to be unrealistic with respect to the capacity to address the thermal load in the room.

### **Labor/Delivery area**

The ventilation rates for labor/ delivery rooms and labor/delivery/ recovery/post partum (LDRP) rooms have increased from 2 total ACH to 6 total ACH. (This rate may be reduced to 4 ACH when supplemental heating and/or cooling are incorporated in the HVAC design for the room.) This is based on the same research<sup>2</sup> that formed the basis for change to the ventilation recommendations for patient rooms.

### **Airborne Infection Isolation Rooms**

Airborne infection isolation (AII) rooms remain at 12 ACH. Recent research<sup>3</sup> using CFD analysis concluded that 10 total ACH was the recommended ventilation rate. Higher rates of ventilation did not decrease the exposure of persons in the room to airborne infectious

agents. Because 10 ACH was considered to be “close” to the now well-accepted 12 ACH recommended by the Centers for Disease Control (CDC),<sup>4</sup> the Guidelines remain at 12 ACH. The CFD modeling provided a substantiating basis for the CDC Guidelines’ recommendation of 12 ACH. It also dispels an inference of the CDC Guidelines that suggest that increasing air exchange rates above 12 ACH will provide additional benefit.

### **Emergency Rooms and Radiology- Waiting and Triage Rooms**

New ventilation recommendations have been established for the first time in ER and radiology waiting and triage rooms. This historic change reflects concerns that these waiting areas are more likely than others to be occupied by persons with undiagnosed communicable respiratory diseases such as tuberculosis.<sup>5</sup> Waiting areas are typically “open areas” rather than enclosed spaces. The basis for the ventilation rate is to supply sufficient ventilation to provide relatively rapid general dilution or filtration of airborne contaminants. The recommended “total” ventilation rate is 12 ACH. The recirculation of the air within this zone with HEPA filters is permissible.<sup>4,6</sup>

### **Procedure Rooms**

Positive pressure rooms. Another major change to the Guidelines was establishing a ventilation rate for “procedure rooms.” This rate is similar to that required for operating rooms. The rooms are designed with airflow out of the rooms, 3 ACH of outside air (OSA) and 15 total ACH. The design intent is to supply a high rate of clean (filtered) air for clean invasive or interventional procedures, thus reducing infectious risks. Typical procedures include cardiac catheterization, interventional radiology, insertion of pacemakers and electrophysiology procedures. Operating rooms and procedure rooms in outpatient or freestanding surgicenters require the same ventilation specifications.

**Negative pressure rooms.** Diagnostic or therapeutic endoscopic procedures involving the airway (i.e., bronchoscopies) increase the risk for air contamination with *M. tuberculosis* in patients with known or undiagnosed tuberculosis, a disease spread by the airborne route. No change was made in the new AIA Guidelines. Bronchoscopy rooms must be maintained at negative air pressure to protect the worker and environment. Special ventilation is not needed for simple procedures carried out in examination or treatment rooms, e.g., minor surgical suture removal.

#### **Procedure Rooms : Usage**

Several types of procedure rooms listed in Table 7.2 are designed with different ventilation recommendations based on variable clinical risk assessments for patients,

staff and environmental control. These recommendations apply to outpatient or freestanding surgicenters as well.

- Positive pressure rooms are comparable to operating rooms and require a total of 15 ACH airflow out of the room. The design intent is to optimize the conditions for clean, invasive procedures, thus reducing infectious risks to the patient. Examples of positive pressure procedure rooms are :
  - Cardiac catheterization or interventional radiology in a radiology suite,
  - Trauma or emergency surgical procedure rooms, and
  - Other invasive procedures such as the insertion of pacemakers or electrophysiology procedures carried out in other locations of inpatient and outpatient facilities. These rooms are not needed for simple physical assessment procedures carried out in examination or treatment rooms such as minor surgical suture removal.
- Negative procedure rooms are comparable to airborne isolation rooms, with different requirements based on their specific usage.

For example: Bronchoscopy rooms, comparable to airborne isolation rooms, require a total of 12 ACH and airflow into the room. The purpose of this design is to eliminate the spread of infectious agents into the surrounding environment from patients with an airborne infectious disease like tuberculosis. The design provides dilution and exhaust of contaminated air from patients with tuberculosis but who must undergo an invasive procedure and reduces risk of exposure to staff performing the procedure.

Endoscopy rooms are designed with 6 ACH and airflow into the procedure room. The number of air changes per hour is less critical than that needed for the control of droplet nuclei (*M. tuberculosis*, *V. zoster*) but a negative pressure improves odor control. This type of clean procedure does not require a positive pressure procedure room since the risk of infectious complication is not from airborne infectious agents.

## Room Pressurization Changes

The room pressurization (“air movement relationship to adjacent area”) has changed for several area designations. Revisions are summarized, and the rationale for each is described briefly in the following section.

### Surgery and Critical Care

- Endoscopy (In)

Negative pressure is required to provide odor control. This is based on clinical experience and changes to negative pressure that are already required by some state codes, e.g., Michigan Minimum Design Standards.<sup>7</sup>

- **Anesthesia Gas Storage (In)**

Airflow into the area assists in containment of leakage of anesthetic gases. This makes the pressure requirement consistent with the recommendation that all air is to be exhausted out of the room and not recirculated.

### Ancillary

- **Pharmacy (Out)**

The change to outward airflow is based on pressure requirements recommended by the American Society of Health System Pharmacists (ASHP). A clean environment is essential for drug admixture processes.

This is based on recommendations from ASHP's national coordinating committee on large volume parenterals; ASHP's quality assurance technical assistance bulletin; and the CDC Guideline for the prevention of intravascular device-related infections.<sup>8-10</sup>

### Diagnostic and Treatment

- **Medication Room (Out)**

The rationale for positive airflow is based on pressure requirements recommended by the American Society of Health System Pharmacists.<sup>8-9</sup>

- **Clean Workroom or Clean Holding (Out)**

The pressure requirements should be positive, whether used to prepare or store clean equipment and/or instruments. Principles of asepsis related to environmental control support the direction of air to flow from clean to soiled areas.<sup>11</sup>

### Sterilizing and Supply

- **Sterile Storage (Out)**

The pressure requirements should be positive to prevent airborne contamination of sterile and clean materials. Principles of asepsis related to environmental control support the direction of airflow from clean to soiled areas.<sup>11</sup>

### Service

- **Clean Linen Storage (Out)**

The pressure requirements should be positive to prevent airborne contamination of clean, stored linen. Principles of asepsis related to environmental control support the direction of airflow from clean to soiled areas.<sup>11</sup>

## Room Pressurization Measurement and Monitors

Another change is the addition of recommendations for the differential pressure for selected special rooms. Note 11 to the AIA Guidelines Table 7.2 specifies that the differential pressure should be a minimum of 0.01 in. w.g. (2.5 Pa) for operating rooms, bronchoscopy rooms, protective environment rooms, and airborne infection isolation rooms. This provides a quantitative factor to evaluate the adequacy of the “air movement relationship to adjacent areas.”

Research and experience<sup>12</sup> on this issue indicates that a pressure differential higher than 0.001 in. w.g. (0.25 Pa) is recommended to 1) reduce adverse effects from normal building pressure fluctuations (due to seasonal variation, winds, etc.); and 2) to provide increased containment/control of airflow for the room. It was acknowledged that the requirement for differential pressure of 0.01 in. w.g. (2.5 Pa) will require increased attention to the construction of the room to reduce airflow leakage (infiltration/exfiltration) via walls, ceilings, etc.

Additionally, there is a new requirement for continuous, visual monitoring of airflow direction in pressurized rooms. A recent report documented frequent failures in maintaining negative pressure in airborne infection isolation rooms. The actual direction of airflow detected by smoke trail tests contradicted the measurements of built-in air pressure differential gauges in more than half of 82 tested rooms.<sup>13</sup>

## Summary

The changes in the ventilation recommendations of the Guidelines reflect:

1. The application of new research, e.g., patient rooms.
2. New concerns for reducing exposure in high-risk areas of the health-care facility, e.g., waiting areas.
3. Consistency with the medical program requirements, e.g., pharmacy, anesthesia gas storage, etc., established on evidence-based clinical research and principles of asepsis.

These changes are the result of a multidisciplinary review of the ventilation requirements and the ventilation recommendations are based on definitive scientific basis.

## Note

This article focuses on the changes related to the ventilation requirements. Many other changes in the 2001 edition are not addressed here.

## References

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