

**high risk immunocompromised patients:** patients who have the greatest risk of infection caused by airborne or waterborne microorganisms. These patients include but are not limited to allogeneic stem-cell transplant patients and intensive chemotherapy patients.

**infection control risk assessment (ICRA):** a determination of the potential risk of transmission of various infectious agents in the facility, a classification of those risks, and a list of required practices for mitigating those risks during construction or renovation.

**immunocompromised patients:** patients whose immune mechanisms are deficient because of immunologic disorders (e.g., human immunodeficiency virus [HIV] infection or congenital immune deficiency syndrome), chronic diseases (e.g., diabetes, cancer, emphysema, or cardiac failure), or immunosuppressive therapy (e.g., radiation, cytotoxic chemotherapy, anti-rejection medication, or steroids) (see CDC [2003] in Informative Annex B: Bibliography).

**inpatient:** a patient whose stay at the health care facility is anticipated to require twenty-four hours or more of patient care.

**invasive imaging procedure room:** a room in which radiographic imaging is used and in which instruments or devices are inserted into patients through the skin or body orifice under sterile conditions for diagnosis and/or treatment.

**non-aspirating diffuser:** a diffuser that has unidirectional downward airflow from the ceiling with minimum entrainment of room air. Classified as ASHRAE Group E, these diffusers generally have very low *average velocity*. For the purposes of this standard, the performance of these diffusers is to be measured in terms of average velocity.

**protective environment room:** a patient room that is designed according to this standard and intended to protect a *high risk immunocompromised patient* from human and environmental airborne pathogens.

**triage:** the process of determining the severity of the illness of or injury to patients so that those who have the most emergent illnesses/injuries can be treated immediately and those less severely injured can be treated later or in another area.

## 4. COMPLIANCE

### 4.1 Compliance Requirements

**4.1.1 New Buildings.** New buildings shall comply with the provisions of this standard.

#### 4.1.2 Existing Buildings

**4.1.2.1 Additions to Existing Buildings.** Additions shall comply with the provisions of this standard.

**4.1.2.2 Alterations to Existing Buildings.** Portions of a heating, ventilating, and air-conditioning system and other systems and equipment that are being altered shall comply with the applicable requirements of this standard.

**4.1.2.2.1 Heating, Ventilation, and Air-Conditioning System Alterations.** Alterations to mechanical systems serving the building heating, cooling, or ventilating needs shall comply

with the requirements of Section 6, "Systems and Equipment," applicable to those specific portions of the building and its systems that are being altered. Any new mechanical equipment installed in conjunction with the alteration as a direct replacement of existing mechanical equipment shall comply with the provisions of Sections 6.2, 6.4, 6.5, and 6.6.

**4.1.2.2.2 Space Alterations.** Alterations to spaces listed in Table 6-1 (see page 5) shall comply with the requirements of Section 6.7 and Section 7, "Space Ventilation," applicable to those specific portions of the building and its systems that are being altered. Any alteration to existing health care space in a building that will continue to treat patients during construction shall comply with Sections 8.1, 8.3, 8.4, and 8.5.

**4.2 Administrative Requirements.** Administrative requirements relating to permit requirements, enforcement by the authority having jurisdiction, interpretations, claims of exemption, approved calculation methods, rights of approved calculation methods, and rights of appeal are specified by the authority having jurisdiction.

### 4.3 Compliance Documents

**4.3.1 General.** Compliance documents are those plans, specifications, engineering calculations, diagrams, reports, and other data that are approved as part of the permit by the authority having jurisdiction. The compliance documents shall include all specific construction-related requirements of the owner's infection control risk assessment.

**4.3.2 Construction Details.** Compliance documents shall contain all pertinent data and features of the building, equipment, and systems in sufficient detail to allow a determination of compliance by the authority having jurisdiction and to indicate compliance with the requirements of this standard.

**4.3.3 Supplemental Information.** Supplemental information necessary to verify compliance with this standard, such as calculations, worksheets, compliance forms, vendor literature, or other data, shall be made available when required by the authority having jurisdiction.

**4.4 Alternate Materials, Methods of Construction, or Design.** The provisions of this standard are not intended to prevent the use of any material, method of construction, design, or building system not specifically prescribed herein, provided such construction, design, or building system has been approved by the authority having jurisdiction as meeting the intent of this standard.

**4.5 Informative Appendices.** The informative appendices to this standard and informative notes located within this standard contain recommendations, explanations, and other non-mandatory information and are not part of this standard.

**4.6 Criteria Ranges.** This standard often specifies a range of values that will comply with a specific requirement of the standard. If it is permitted by the authority having jurisdiction, compliance with this requirement may be achieved by the presentation of compliance documents that demonstrate a system's ability to perform within the specified range.

## 5. PLANNING

Owners/managers of health care facilities shall prepare a detailed program that shall include the clinical service expected in each space, the specific equipment expected to be used in each space, and any special clinical needs for temperature, humidity, and pressure control. This program shall be prepared in the planning phase of design.

## 6. SYSTEMS AND EQUIPMENT

Air-handling and distribution systems are required to provide health care facilities not only with a comfortable environment but also with ventilation to dilute and remove contaminants, to provide conditioned air, and to assist in controlling the transmission of airborne infection. In order to meet these requirements, air-handling and distribution systems shall be designed according to the requirements of this standard.

### 6.1 Utilities

**6.1.1 Ventilation Upon Loss of Electrical Power.** The space ventilation and pressure relationship requirements of Table 7-1 (see page 7) shall be maintained for the following spaces, even in the event of loss of normal electrical power:

- a. All rooms
- b. PE rooms
- c. Class B & C Operating Rooms, including Delivery Rooms (Caesarean)

For further information, see NFPA 99 (2005), in Informative Annex B: Bibliography.

### 6.1.2 Reserve Heating and Cooling Sources

**6.1.2.1** Provide heat sources and essential accessories in number and arrangement sufficient to accommodate the facility needs, even when any one of the heat sources is not operating due to a breakdown or routine maintenance. The capacity of the remaining source(s) shall be sufficient to provide for sterilization and dietary purposes and to provide heating for operating, delivery, birthing, labor, recovery, emergency, intensive care, nursery, and inpatient rooms. (For further information, see AIA (2006) in Informative Annex B: Bibliography.)

**Exception:** Reserve capacity is not required if the ASHRAE 99% heating dry bulb temperature for the facility is greater than or equal to 25°F.

**6.1.2.2** For central cooling systems greater than 400 tons peak cooling load, the number and arrangement of cooling sources and essential accessories shall be sufficient to support the owner's facility operation plan upon a breakdown or routine maintenance of any one of the cooling sources.

**Exception:** Reserve capacity is not required if the ASHRAE 1% cooling dry bulb temperature is less than or equal to 85°F.

### 6.2 Air-Handling Unit Design

**6.2.1 Air-Handling Unit Casing.** The casing of the air-handling unit shall be designed to prevent water intrusion, resist corrosion, and permit access for inspection and maintenance.

All airstream surfaces of air-handling units—e.g., interior surfaces and components—shall comply with Section 5.5 of *ANSI/ASHRAE Standard 62.1-2007, Ventilation for Acceptable Indoor Air Quality*. (For more information, see ANSI/ASHRAE Standard 62.1-2007 and ASHRAE position document *Minimizing Indoor Mold Problems through Management of Moisture in Building Systems*.)

### 6.3 Outdoor Air Intakes and Exhaust Discharges

**6.3.1 Outdoor Air Intakes.** Outdoor air intakes for air-handling units shall be located a minimum of 25 ft (8 m) from cooling towers and all exhaust and vent discharges. Outdoor air intakes shall be located such that the bottom of the air intake is at least six ft (2 m) above grade. Intakes on top of buildings shall be located a minimum of three ft (1 m) above roof level. New facilities with moderate-to-high risk of natural or man-made extraordinary incidents shall locate air intakes away from public access. All intakes shall be designed to prevent the entrainment of wind-driven rain, shall contain features for draining away precipitation, and shall be equipped with a birdscreen of mesh no smaller than 0.5 in. (13 mm).

**6.3.2 Exhaust Discharges.** Exhaust discharge outlets that discharge air from AII rooms, bronchoscopy rooms, emergency department waiting rooms, nuclear medicine laboratories, radiology waiting, and laboratory chemical fume hoods shall

- a. be designed so that all ductwork in occupied spaces is under negative pressure;
- b. discharge in a vertical direction at least 10 ft (3 m) above roof level and shall be located not less than 10 ft horizontally from air intakes, openable windows/doors, or areas that are normally accessible to the public or maintenance personnel and that are higher in elevation than the exhaust discharge; and
- c. be located such that they minimize the recirculation of exhausted air back into the building.

**6.4 Filtration.** Filter banks shall be provided in accordance with Table 6-1. Each filter bank with an efficiency of greater than MERV 12 shall be provided with an installed manometer or differential pressure measuring device that is readily accessible and provides a reading of differential static pressure across the filter to indicate when the filter needs to be changed. (For further information, see AIA [2006] and CDC [2003] in Informative Annex B: Bibliography.)

**6.4.1 First Filtration Bank.** Filter Bank No. 1 shall be placed upstream of the heating and cooling coils such that all mixed air is filtered.

**6.4.2 Second Filtration Bank.** Filter Bank No. 2 shall be installed downstream of all wet air cooling coils and the supply fan. All second filter banks shall have sealing interface surfaces.

### 6.5 Heating and Cooling Systems

**6.5.1 Cooling Coils and Drain Pans.** Cooling coils and drain pans shall comply with the requirements of ANSI/ASHRAE Standard 62.1-2007.

**TABLE 6-1 Minimum Filter Efficiencies**

Space Designation (According to Function)	Filter Bank Number 1 (MERV) <sup>a</sup>	Filter Bank Number 2 (MERV) <sup>a</sup>
Classes B and C surgery; inpatient and ambulatory diagnostic and therapeutic radiology; inpatient delivery and recovery spaces	7	14
Inpatient care, treatment, and diagnosis, and those spaces providing direct service or clean supplies and clean processing (except as noted below); AII (rooms)	7	14
Protective environment rooms (PE)	7	17 (HEPA) <sup>c</sup>
Laboratories; Class A surgery and associated semi-restricted spaces	13 <sup>b</sup>	N/R*
Administrative; bulk storage; soiled holding spaces; food preparation spaces; and laundries	7	N/R
All other outpatient spaces	7	N/R
Skilled nursing facilities	7	N/R

\* NR = not required

Note a: The minimum efficiency reporting value (MERV) is based on the method of testing described in *ANSI/ASHRAE Standard 52.2-2007, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size* (see Informative Annex B: Bibliography).

Note b: Additional prefilters may be used to reduce maintenance for filters with efficiencies higher than MERV 7.

Note c: Filter Bank No. 2 may be a MERV 14 if a MERV 17 tertiary terminal filter is provided for these spaces.

**TABLE 6-2 Supply Air Outlets**

Space Designation (According to Function)	Supply Air Outlet Classification <sup>a</sup>
All class A, B, and C surgeries <sup>b</sup>	Primary supply diffusers Group E, non-aspirating additional supply diffusers, Group E
Protective environment (PE) rooms	Group E, non-aspirating
Wound intensive care units (burn units)	Group E, non-aspirating
Trauma rooms (crisis or shock)	Group E, non-aspirating
AII rooms	Group A or Group E
All other spaces	Group A or Group E

Note a: Refer to *2005 ASHRAE Handbook—Fundamentals*, Chapter 35, for definitions related to outlet classification and performance (see Informative Annex B: Bibliography).

Note b: Surgeons may require alternate air-distribution systems for some specialized surgeries. Such systems shall be considered acceptable if they meet or exceed the requirements of this standard.

**6.5.2 Radiant Cooling Systems.** If radiant cooling panels are utilized, the chilled-water temperature shall always remain above the dew point temperature of the space.

**6.5.3 Radiant Heating Systems.** If radiant heating is provided for an AII room, a protective environment room, a wound intensive care unit (burn unit), or a room for any class of surgery, either flat and smooth radiant ceiling panels with exposed cleanable surfaces or radiant floor heating shall be used.

**6.6 Humidifiers.** When outdoor humidity and internal moisture sources are not sufficient to meet the requirements of Table 7-1, humidification shall be provided by means of the health-care facility air-handling systems. Locate humidifiers within air-handling units or ductwork to avoid moisture accumulation in downstream components, including filters and insulation. Chemical additives used for steam humidifiers serving health care facilities shall comply with FDA requirements.<sup>1</sup> Reservoir-type water humidifiers or evaporative-pan-type humidifiers shall not be used in ductwork or air-handling units in health care facilities. A humidity sensor shall be provided, located at a suitable distance downstream from the steam injection source. Controls shall be provided to limit duct humidity to a maximum value of

90% RH when the humidifier is operating. Humidifier steam control valves shall be designed so that they remain OFF whenever the air-handling unit is not in operation.

## 6.7 Air Distribution Systems

**6.7.1 General.** Maintain the pressure relationships required in Table 7-1 in all modes of HVAC system operation, except as noted in the table. Spaces listed in Table 7-1 that have required pressure relationships shall be served by fully ducted returns. The air-distribution design shall maintain the required space pressure relationships, taking into account recommended maximum filter loading, heating-season lowered airflow operation, and cooling-season higher airflow operation. Airstream surfaces of the air-distribution system downstream of Filter Bank No. 2, shall comply with Section 5.5 of ANSI/ASHRAE Standard 62.1-2007. The air-distribution system shall be provided with access doors, panels, or other means to allow convenient access for inspection and cleaning. (For further information, see ANSI/ASHRAE Standard 62.1.)

**6.7.2 Air-Distribution Devices.** All air-distribution devices shall meet the following requirements:

- a. Surfaces of air-distribution devices shall be suitable for cleaning. Supply air outlets in accordance with Table 6-2 shall be used.
- b. The supply diffusers in Classes B and C surgeries shall be designed and installed to allow for internal cleaning.
- c. Psychiatric, seclusion, and holding-patient rooms shall be designed with security diffusers, grilles, and registers.

## 7. SPACE VENTILATION

The ventilation requirements of this standard are minimums that provide control of environmental comfort, asepsis, and odor in health care facilities. However, because they are minimum requirements and because of the diversity of the population and variations in susceptibility and sensitivity, these requirements do not provide assured protection from discomfort, airborne transmission of contagions, and odors.

**7.1 General Requirements.** The following general requirements shall apply for space ventilation:

1. Spaces shall be ventilated according to Table 7-1.
  - a. Design of the ventilation system shall provide air movement that is generally from clean to less clean areas. If any form of variable-air-volume or load-shedding system is used for energy conservation, it shall not compromise the pressure balancing relationships or the minimum air changes required by the table. See Table 7-1 note (t) for additional information.
  - b. The ventilation rates in this table are intended to provide for comfort as well as for asepsis and odor control in areas of a health care facility that directly affect patient care. The air change rates specified are for supply in positive pressure rooms and for exhaust in negative pressure rooms. Ventilation rates for many areas not specified here can be found in ANSI/ASHRAE Standard 62.1 (see Informative Annex B: Bibliography). Where areas with prescribed rates in both Standard 62.1-2007 and Table 7-1 of this standard exist, the higher of the two air change rates shall be used.
  - c. 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. 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 tempera-

ture and humidity conditions based upon the space cooling or heating load.

2. Air filtration for spaces shall comply with Table 6-1.
3. Supply air outlets for spaces shall comply with Table 6-2.
4. In All rooms, protective environment rooms, wound intensive care units (burn units), and rooms for all classes of surgery, heating with supply air or radiant panels that meet the requirements of Section 6.5.3 shall be provided.

## 7.2 Additional Room Specific Requirements

**7.2.1 Airborne Infection Isolation (AII) Rooms.** Ventilation for AII rooms shall meet the following requirements whenever an infectious patient occupies the room:

- a. Each AII room shall comply with requirements of Tables 6-1, 6-2, and 7-1. All rooms shall have a permanently installed device and/or mechanism to constantly monitor the differential air pressure between the room and adjacent spaces of the room when occupied by patients with an airborne infectious disease. A local visual means shall be provided to indicate whenever negative differential pressure is not maintained.
- b. All air from the AII room shall be exhausted directly to the outdoors.

**Exception:** AII rooms that are retrofitted from standard patient rooms from which it is impractical to exhaust directly outdoors may be ventilated with recirculated air from the room's exhaust, provided that the air first passes through a HEPA (MERV 17) filter.
- c. All exhaust air from the AII rooms, associated anterooms, and associated toilet rooms shall be discharged directly to the outdoors without mixing with exhaust air from any other non-AII room or exhaust system.
- d. Exhaust air grilles or registers in the patient room shall be located directly above the patient bed on the ceiling or on the wall near the head of the bed unless it can be demonstrated that such a location is not practical.
- e. The room envelope shall be sealed to limit leakage air flow at 0.01 in. wc (2.5 Pa) differential pressure across the envelope.
- f. Differential pressure between AII rooms and adjacent spaces that have a different function shall be a minimum of  $-0.01$  in. wc ( $-2.5$  Pa).

**7.2.2 Protective Environment (PE) Rooms.** Ventilation for PE rooms shall meet the following requirements:

- a. The room envelope shall be sealed to limit leakage air flow at 0.01 in. wc (2.5 Pa) differential pressure across the envelope.
- b. Each PE room shall comply with the requirements of Tables 6-1, 6-2, and 7-1. PE rooms shall have a permanently installed device and/or mechanism to constantly monitor the differential air pressure between the room and adjacent spaces of the room when occupied by patients requiring a protective environment. A local visual means shall be provided to indicate whenever positive differential pressure is not maintained.