

ASHRAE/ASHE STANDARD

Ventilation of Health Care Facilities

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NOTE

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FOREWORD

ANSI/ASHRAE/ASHE Standard 170, Ventilation of Health Care Facilities, is one of a family of documents that offers guidance, regulation, and mandates to designers of health care facilities. It is first and foremost a mandatory minimum requirement and, as such, may not offer the state-of-the-art best practice of health care ventilation design. Other publications, such as the ASHRAE HVAC Design Manual for Hospitals and Clinics, may provide more depth and detail for the designer. In addition, the health care designer must refer to any design requirements from the appropriate jurisdiction that has authority. Many jurisdictions use or refer to Guidelines for Design and Construction of Hospitals and Health Care Facilities, published by the American Institute of Architects (AIA). Where practical, the committee was cognizant of these other documents in the development of this standard.

Ventilation design for health care spaces is a combination of tasks that leads to a set of documents used in construction. One such task requires medical planners to develop departmental programs of spaces. These programs include space names that suggest the use for which the space is intended, and health care ventilation designers depend upon these names to determine the ventilation parameters for their designs. This standard provides these ventilation parameters.

Without high-quality ventilation in health care facilities, patients, health care workers, and visitors can become infected through normal respiration of particles in the air. Poorly ventilated health care facilities are places where the likelihood of pathogenic particles occurring in the air is quite high. These air-transmitted pathogens can be found everywhere in poorly ventilated health care facilities, and although most individuals can cope using their healthy immune systems, some patients are susceptible to these pathogens or even to normal environmental air-borne organisms such as fungal spores. Because these organisms are found in higher concentrations in hospitals, additional care must be taken in design of the ventilation systems.

1. PURPOSE

The purpose of this standard is to define ventilation system design requirements that provide environmental control for comfort, asepsis, and odor in health care facilities.

2. SCOPE

2.1 The requirements in this standard apply to patient care areas and related support areas within health care facilities, including hospitals, nursing facilities, and outpatient facilities.

2.2 This standard applies to new buildings, additions to existing buildings, and those alterations to existing buildings that are identified within this standard.

2.3 This standard considers chemical, physical, and biological contaminants that can affect the delivery of medical care to patients; the convalescence of patients; and the safety of patients, health care workers, and visitors.

3. DEFINITIONS

addition: an extension or increase in floor area or height of a building, building system, or equipment.

airborne infection isolation (AII): the isolation of patients infected with organisms spread by airborne droplet nuclei less than 5 μm in diameter (see CDC [2003] in Informative Annex B: Bibliography). For the purposes of this standard, the abbreviation "AII" refers to the room that provides isolation.

airborne infection isolation room: a room that is designed according to the requirements of this standard and that is intended to provide *airborne infection isolation*.

alteration: a significant change in the function or size of a space, in the use of its systems, or in the use of its equipment, either through rearrangement, replacement, or addition. Routine maintenance and service shall not constitute an alteration.

authority having jurisdiction: the agent or agency responsible for enforcing this standard.

average velocity: the volumetric flow rate obtained by dividing the air quantity issuing from an air distribution device by the nominal face area of the device.

building: a structure that is wholly or partially enclosed within exterior walls and a roof, or within exterior and party walls and a roof, and that affords shelter to persons, animals, or property. In this standard, a building is a structure intended for use as a hospital or health care facility.

classification of surgeries:

Class A surgery: provides minor surgical procedures performed under topical, local, or regional anesthesia without preoperative sedation. Excluded are intravenous, spinal, and epidural procedures, which are Class B or C surgeries.

Class B surgery: provides minor or major surgical procedures performed in conjunction with oral, parenteral, or intravenous sedation or performed with the patient under analgesic or dissociative drugs.

Class C surgery: provides major surgical procedures that require general or regional block anesthesia and/or support of vital bodily functions.

For more information on this method of classifying surgeries, see ACS (2000) in Informative Annex B: Bibliography.

equipment: devices for heating, ventilating, and/or air conditioning, including but not limited to furnaces, boilers, air conditioners, heat pumps, chillers, and heat exchangers.

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 (2001) 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) ^a	Filter Bank Number 2 (MERV) ^a
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); All (rooms)	7	14
Protective environment rooms (PE)	7	17 (HEPA) ^c
Laboratories; Class A surgery and associated semi-restricted spaces	13 ^b	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 ^a
All class A, B, and C surgeries ^b	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
All 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 All 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.¹ 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. AII 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.

TABLE 7-1 Design Parameters

Function of Space	Pressure Relationship to Adjacent Areas (n)	Minimum Outdoor ach	Minimum Total ach	All Room Air Exhausted Directly to Outdoors (j)	Air Recirculated by Means of Room Units (a)	RH (k), %	Design Temperature (l), °F/°C
SURGERY AND CRITICAL CARE							
Classes B and C operating rooms, (m), (n), (o)	Positive	4	20	N/R	No	30-60	68-75/20-24
Operating/surgical cystoscopic rooms, (m), (n) (o)	Positive	4	20	N/R	No	30-60	68-75/20-24
Delivery room (Caesarean) (m), (n), (o)	Positive	4	20	N/R	No	30-60	68-75/20-24
Substerile service area	N/R	2	6	N/R	No	N/R	N/R
Recovery room	N/R	2	6	N/R	No	30-60	70-75/21-24
Critical and intensive care	Positive	2	6	N/R	No	30-60	70-75/21-24
Wound intensive care (burn unit)	Positive	2	6	N/R	No	40-60	70-75/21-24
Newborn intensive care	Positive	2	6	N/R	No	30-60	70-75/21-24
Treatment room (p)	N/R	2	6	N/R	N/R	30-60	70-75/21-24
Trauma room (crisis or shock) (c)	Positive	3	15	N/R	No	30-60	70-75/21-24
Medical/anesthesia gas storage (f)	Negative	N/R	8	Yes	N/R	N/R	N/R
Laser eye room	Positive	3	15	N/R	No	30-60	70-75/21-24
ER waiting rooms (q)	Negative	2	12	Yes	N/R	max 65	70-75/21-24
Triage	Negative	2	12	Yes	N/R	max 60	70-75/21-24
ER decontamination	Negative	2	12	Yes	No	N/R	N/R
Radiology waiting rooms (q)	Negative	2	12	Yes	N/R	max 60	70-75/21-24
Class A Operating/Procedure room (o), (d)	Positive	3	15	N/R	No	30-60	70-75/21-24
INPATIENT NURSING							
Patient room (s)	N/R	2	6	N/R	N/R	max 60	70-75/21-24
Toilet room	Negative	N/R	10	Yes	No	N/R	N/R
Newborn nursery suite	N/R	2	6	N/R	No	30-60	72-78/22-26
Protective environment room (f), (n), (t)	Positive	2	12	N/R	No	max 60	70-75/21-24
All room (e), (n), (u)	Negative	2	12	Yes	No	max 60	70-75/21-24
All isolation anteroom (t) (u)	N/R	N/R	10	Yes	No	N/R	N/R
Labor/delivery/recovery/postpartum (LDRP) (s)	N/R	2	6	N/R	N/R	max 60	70-75/21-24
Labor/delivery/recovery (LDR) (s)	N/R	2	6	N/R	N/R	max 60	70-75/21-24

Note: N/R = no requirement

TABLE 7-1 Design Parameters

Function of Space	Pressure Relationship to Adjacent Areas (n)	Minimum Outdoor ach	Minimum Total ach	All Room Air Exhausted Directly to Outdoors (j)	Air Recirculated by Means of Room Units (a)	RH (k), %	Design Temperature (l), °F/°C
Corridor	N/R	N/R	2	N/R	N/R	N/R	N/R
SKILLED NURSING FACILITY							
Resident room	N/R	2	2	N/R	N/R	N/R	70-75/21-24
Resident gathering/activity/dining	N/R	4	4	N/R	N/R	N/R	70-75/21-24
Physical therapy	Negative	2	6	N/R	N/R	N/R	70-75/21-24
Occupational therapy	N/R	2	6	N/R	N/R	N/R	70-75/21-24
Bathing room	Negative	N/R	10	Yes	N/R	N/R	70-75/21-24
RADIOLOGY (v)							
X-ray (diagnostic and treatment)	N/R	2	6	N/R	N/R	max 60	72-78/22-26
X-ray (surgery/critical care and catheterization)	Positive	3	15	N/R	No	max 60	70-75/21-24
Darkroom (g)	Negative	2	10	Yes	No	N/R	N/R
DIAGNOSTIC AND TREATMENT							
Bronchoscopy, sputum collection, and pentamidine administration (n)	Negative	2	12	Yes	No	N/R	68-73/20-23
Laboratory, general (v)	Negative	2	6	N/R	No	N/R	70-75/21-24
Laboratory, bacteriology (v)	Negative	2	6	Yes	No	N/R	70-75/21-24
Laboratory, biochemistry (v)	Negative	2	6	Yes	No	N/R	70-75/21-24
Laboratory, cytology (v)	Negative	2	6	Yes	No	N/R	70-75/21-24
Laboratory, glasswashing	Negative	2	10	Yes	No	N/R	N/R
Laboratory, histology (v)	Negative	2	6	Yes	No	N/R	70-75/21-24
Laboratory, microbiology (v)	Negative	2	6	Yes	No	N/R	70-75/21-24
Laboratory, nuclear medicine (v)	Negative	2	6	Yes	No	N/R	70-75/21-24
Laboratory, pathology (v)	Negative	2	6	Yes	No	N/R	70-75/21-24
Laboratory, serology (v)	Negative	2	6	Yes	No	N/R	70-75/21-24
Laboratory, sterilizing	Negative	2	10	Yes	No	N/R	70-75/21-24
Laboratory, media transfer (v)	Positive	2	4	N/R	No	N/R	70-75/21-24
Autopsy room (n)	Negative	2	12	Yes	No	N/R	68-75/20-24
Nonrefrigerated body-holding room (h)	Negative	N/R	10	Yes	No	N/R	70-75/21-24
Pharmacy (b)	Positive	2	4	N/R	N/R	N/R	N/R

Note: N/R = no requirement

TABLE 7-1 Design Parameters

Function of Space	Pressure Relationship to Adjacent Areas (n)	Minimum Outdoor ach	Minimum Total ach	All Room Air Exhausted Directly to Outdoors (j)	Air Recirculated by Means of Room Units (a)	RH (k), %	Design Temperature (l), °F/°C
Examination room	N/R	2	6	N/R	N/R	max 60	70-75/21-24
Medication room	Positive	2	4	N/R	N/R	max 60	70-75/21-24
Endoscopy	Positive	2	15	N/R	No	30-60	68-73/20-23
Endoscope cleaning	Negative	2	10	Yes	No	N/R	N/R
Treatment room	N/R	2	6	N/R	N/R	max 60	70-75/21-24
Hydrotherapy	Negative	2	6	N/R	N/R	N/R	72-80/22-27
Physical therapy	Negative	2	6	N/R	N/R	Max 65	72-80/22-27
STERILIZING							
Sterilizer equipment room	Negative	N/R	10	Yes	No	N/R	N/R
CENTRAL MEDICAL AND SURGICAL SUPPLY							
Soiled or decontamination room	Negative	2	6	Yes	No	N/R	72-78/22-26
Clean workroom	Positive	2	4	N/R	No	max 60	72-78/22-26
Sterile storage	Positive	2	4	N/R	N/R	max 60	72-78/22-26
SERVICE							
Food preparation center (i)	N/R	2	10	N/R	No	N/R	72-78/22-26
Warewashing	Negative	N/R	10	Yes	No	N/R	N/R
Dietary storage	N/R	N/R	2	N/R	No	N/R	72-78/22-26
Laundry, general	Negative	2	10	Yes	No	N/R	N/R
Soiled linen sorting and storage	Negative	N/R	10	Yes	No	N/R	N/R
Clean linen storage	Positive	N/R	2	N/R	N/R	N/R	72-78/22-26
Linen and trash chute room	Negative	N/R	10	Yes	No	N/R	N/R
Bedpan room	Negative	N/R	10	Yes	No	N/R	N/R
Bathroom	Negative	N/R	10	Yes	No	N/R	72-78/22-26
Janitor's closet	Negative	N/R	10	Yes	No	N/R	N/R
SUPPORT SPACE							
Soiled workroom or soiled holding	Negative	2	10	Yes	No	N/R	N/R
Clean workroom or clean holding	Positive	2	4	N/R	N/R	N/R	N/R
Hazardous material storage	Negative	2	10	Yes	No	N/R	N/R

Note: N/R = no requirement

Table 7-1 Notes:

- a. Recirculating room HVAC units (with heating or cooling coils) are acceptable to achieve the required air change rates. Because of the cleaning difficulty and the potential for buildup of contamination, recirculating room units shall not be used in areas marked "No." Isolation and intensive care unit rooms may be ventilated by reheat induction units in which only the primary air supplied from a central system passes through the reheat unit. Gravity-type heating or cooling units, such as radiators or convectors, shall not be used in operating rooms and other special care areas.
- b. Pharmacy compounding areas may have additional air change and filtering requirements beyond the minimum of this table depending on the type of pharmacy, the regulatory requirements (which may include adoption of USP 797), the associated level of risk of the work (see USP 797), and the equipment utilized in the spaces.
- c. The term *trauma room* as used herein is a first aid room and/or emergency room used for general initial treatment of accident victims. The operating room within the trauma center that is routinely used for emergency surgery is considered to be an operating room by this Standard.
- d. Pressure relationships need not be maintained when the room is unoccupied.
- e. Some isolation rooms may be provided with a separate anteroom, but an ante room is not required by this standard.
- f. Protective environment rooms are those used for high-risk immunocompromised patients. Such rooms are positively pressurized relative to all adjoining spaces to protect the patient.
- g. Exception: All air need not be exhausted if darkroom equipment has a scavenging exhaust duct attached and meets ventilation standards regarding NIOSH, OSHA, and local employee exposure limits.^{2, 3}
- h. A nonrefrigerated body-holding room is applicable only to facilities that do not perform autopsies on-site and use the space for short periods while waiting for the body to be transferred.
- i. Minimum total air changes per hour (ach) shall be that required to provide proper makeup air to kitchen exhaust systems as specified in ANSI/ASHRAE Standard 154.⁴ In some cases, excess exfiltration or infiltration to or from exit corridors compromises the exit corridor restrictions of NFPA 90A,⁵ the pressure requirements of NFPA 96,⁶ or the maximum defined in the table. During operation or infiltration to the number of air changes to any extent required for odor control shall be permitted when the space is not in use. (See AIA [2006] in Informative Annex B: Bibliography.)
- j. In some areas with potential contamination and/or odor problems, exhaust air shall be discharged directly to the outdoors and not recirculated to other areas. Individual circumstances may require special consideration for air exhausted to the outdoors, for example, intensive care units in which patients with pulmonary infection are treated and rooms for burn patients. To satisfy exhaust needs, constant replacement air from the outdoors is necessary when the system is in operation.
- k. The RH ranges listed are the minimum and maximum limits where control is specifically needed.
- l. Systems shall be capable of maintaining the rooms within the range during normal operation. Lower or higher temperature shall be permitted when patients' comfort and/or medical conditions require those conditions.
- m. National Institute for Occupational Safety and Health (NIOSH) criteria documents regarding occupational exposure to waste anesthetic gases and vapors, and control of occupational exposure to nitrous oxide⁷ indicate a need for both local exhaust (scavenging) systems and general ventilation of the areas in which the respective gases are utilized. Refer to NFPA 99 for other requirements.⁸
- n. If 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. Recirculating devices with HEPA filters shall be permitted in existing facilities as interim, supplemental environmental controls to meet requirements for the control of airborne infectious agents. The design of either portable or fixed systems should prevent stagnation and short circuiting of airflow. The design of such systems shall also allow for easy access for scheduled preventative maintenance and cleaning.
- o. Surgeons or surgical procedures may require room temperatures, ventilation rates, humidity ranges, and/or air distribution methods that exceed the minimum indicated ranges.
- p. Treatment rooms used for bronchoscopy shall be treated as bronchoscopy rooms. Treatment rooms used for procedures with nitrous oxide shall contain provisions for exhausting anesthetic waste gases.
- q. In a recirculating ventilation system, HEPA filters shall be permitted instead of exhausting the air from these spaces to the outdoors provided the return air passes through the HEPA filters before it is introduced into any other spaces. This requirement applies only to waiting rooms programmed to hold patients awaiting chest x-rays for diagnosis of respiratory disease.
- r. See NFPA 99 for further requirements.⁸
- s. For patient rooms, labor/delivery/recovery rooms, and labor/delivery/recovery/postpartum rooms, four total ach shall be permitted when supplemental heating and/or cooling systems (radiant heating and cooling, baseboard heating, etc.) are used.
- t. The protective environment airflow design specifications protect the patient from common environmental airborne infectious microbes (i.e., *Aspergillus* spores). Recirculation HEPA filters shall be permitted to increase the equivalent room air exchanges; however, the outdoor air changes are still required. Constant volume airflow is required for consistent ventilation for the protected environment. If the design criteria indicate that AII is necessary for protective environment patients, an anteroom should be provided. Rooms with reversible airflow provisions for the purpose of switching between protective environment and AII functions shall not be permitted.
- u. The AII room described in this standard shall be used for isolating the airborne spread of infectious diseases, such as measles, varicella, or tuberculosis. The design of AII rooms shall include the provision for normal patient care during periods not requiring isolation precautions. Supplemental recirculating devices using HEPA filters shall be permitted in the patient room to increase the equivalent room air exchanges; however, the outdoor air changes are still required. AII rooms that are retrofitted from standard patient rooms from which it is impractical to exhaust directly outside may be recirculated with air from the AII room, provided that the air first passes through a HEPA filter. HEPA filtered exhaust air from AII rooms may mix with exhaust air that serves non-AII spaces prior to being discharged directly outdoors. Rooms with reversible airflow provisions for the purpose of switching between protective environment and AII functions shall not be permitted. See the guidelines in Informative Annex B: Bibliography for more information.
- v. When required, appropriate hoods and exhaust devices for the removal of noxious gases or chemical vapors shall be provided in accordance with NFPA 99.⁸

- c. Air distribution patterns within the protective environment room shall conform to the following:
 - Supply air diffusers shall be above the patient bed, unless it can be demonstrated that such a location is not practical. Diffuser design shall limit air velocity at the patient bed to reduce patient discomfort. (See *ANSI/ASHRAE Standard 55-2004, Thermal Environmental Conditions for Human Occupancy*, in Informative Annex B: Bibliography.)
 - Return/exhaust grilles or registers shall be located near the patient room door.
- d. Differential pressure between any dissimilar adjacent spaces shall be a minimum of +0.01 in. wc (+2.5 Pa).
- e. PE rooms retrofitted from standard patient rooms may be ventilated with recirculated air, provided that air first passes through a HEPA filter and the room complies with parts "a" through "d" of this section.

7.3 Critical Care Units

7.3.1 Wound Intensive Care Units (Burn Units). Burn unit patient rooms that require humidifiers to comply with Table 7-1 shall be provided with individual humidity control.

7.4 Surgery Rooms

7.4.1 Class B and C Operating Rooms. Operating 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. wc (2.5 Pa). Operating rooms shall be provided with primary supply diffusers that are designed as follows:

- a. The airflow shall be unidirectional, downwards, and the *average velocity* of the diffusers shall be 25 to 35 cfm/ft² (127 L/s/m² to 178 L/s/m²). The diffusers shall be concentrated to provide an airflow pattern over the patient and surgical team. (see Memarzadeh [2002] and Memarzadeh [2004] in Informative Annex B: Bibliography.)
- b. The area of the primary supply diffuser array shall extend a minimum of 12 in. (305 mm) beyond the footprint of the surgical table on each side. No more than 30% of the primary supply diffuser array area shall be used for non-diffuser uses such as lights, gas columns, etc. Additional supply diffusers may be required to provide additional ventilation to the operating room to achieve the environmental requirements of Table 7-1 relating to temperature, humidity, etc.

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, with the bottom of these grilles installed approximately 8 in. (203 mm) above the floor.

7.4.2 Sterilization Rooms. Steam that escapes from a steam sterilizer shall be exhausted using an exhaust hood or other suitable means. Ethylene oxide that escapes from a gas sterilizer shall be exhausted using an exhaust hood or other suitable means.

7.4.3 Imaging Procedure Rooms. If invasive procedures occur in this type of room, ventilation shall be provided in

accordance with the ventilation requirements for Class A surgery. If anesthetic gases are administered, ventilation shall be provided in accordance with the ventilation requirements for Class B or C surgery.

7.5 Support Spaces

7.5.1 Morgue and Autopsy Rooms. Low sidewall exhaust grilles shall be provided unless exhaust air is removed through an autopsy table designed for this purpose. All exhaust air from autopsy, nonrefrigerated body-holding, and morgue rooms shall be discharged directly to the outdoors without mixing with air from any other room or exhaust system.

8. PLANNING, CONSTRUCTION, AND SYSTEM STARTUP

8.1 Overview. For HVAC systems serving surgery and critical care spaces, compliance with this standard requires preparation of an acceptance testing plan.

8.2 Planning for the HVAC Services in a New Facility. Design documents for new construction shall meet the following requirements:

- a. *General Mechanical Equipment Rooms.* The access to mechanical rooms shall be planned to avoid the intrusion of maintenance personnel into surgical and critical care patient spaces.
- b. *Mechanical Room Layout.* Mechanical room layout shall include sufficient space for access to equipment for operation, maintenance, and replacement. Floors in mechanical rooms shall be sealed, including sealing around all penetrations, when they are above surgical suites and critical care.
- c. *Maintenance/Repair Personnel Access.* Safe and practical means of accessing equipment shall be provided. Clearance is required at all service points to mechanical equipment to allow personnel access and working space. The access to mechanical equipment shall be planned to make it unnecessary for maintenance personnel to intrude into surgical or critical care rooms.
- d. *Cooling Towers.* Cooling towers shall be located so that drift is directed away from air-handling unit intakes. They shall meet the requirements of Section 6.3.2.

8.3 Planning for the HVAC Services in an Existing Facility. If any existing air-handling equipment is reused, the designer shall evaluate the capacity of the equipment to determine whether it will meet the requirements of this standard for the remodeled space.

8.4 Planning for Infection Control During Remodeling of an Existing Facility. Prior to beginning modifications or remodeling of HVAC systems in an existing facility, an owner shall conduct an infection control risk assessment (ICRA). The ICRA shall establish those procedures required to minimize the disruption of facility operation and the distribution of dust, odors and particulates.

8.5 Documentation of New or Remodeled HVAC Systems. Owners shall retain an acceptance testing report for their files. In addition, the design shall include requirements for operations and maintenance staff training that is sufficient for the staff to keep all HVAC equipment in a condition that will maintain the original design intent for ventilation. Training of operating staff shall include an explanation of the design intent. The training materials shall include, at a minimum, the following:

- a. O&M procedures
- b. Temperature and pressure control operation in all modes
- c. Acceptable tolerances for system temperatures and pressures
- d. Procedures for operations under emergency power or other abnormal conditions that have been considered in the facility design.

8.6 Duct Cleanliness. The duct supply system shall meet the following requirements for cleanliness:

- a. The duct system shall be free of construction debris. New supply duct system installations shall comply with level "B," the Intermediate Level of SMACNA Duct Cleanliness for New Construction Guidelines.⁹
- b. The supply diffusers in the Class B & C operating rooms shall be opened and cleaned before the space is used.
- c. The permanent HVAC systems shall not be operated unless protection from contamination of the air distribution system is provided.

9. NORMATIVE REFERENCES

- ¹ Code of Federal Regulations: 21CFR 173.310 (April 1999), US Dept. of Health and Human Services, Food and Drug Administration.
- ² DHHS (NIOSH) Publication No. 94-100 (NIOSH Alert) *Controlling Exposures to Nitrous Oxide During Anesthetic Administration*, National Institute for Occupational Safety and Health (CDC), Atlanta, GA.
- ³ OSHA [1994]. Computerized information system. Washington, DC: U.S. Department of Labor, Occupational Safety and Health Administration.
- ⁴ ANSI/ASHRAE Standard 154-2003 *Ventilation for Commercial Cooking Operations*, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Atlanta, GA.
- ⁵ NFPA 90A. National Fire Protection Association 1 Batterymarch Park, Quincy, MA 02169.
- ⁶ NFPA 96. National Fire Protection Association 1 Batterymarch Park, Quincy, MA 02169.
- ⁷ NIOSH Critical Documents. National Institute for Occupational Safety and Health, available at the Centers for Disease Control and Prevention (CDC) web site: http://www.cdc.gov/niosh/pubs/criteria_date_desc_nopubnumbers.html
- ⁸ NFPA 99-2005: *Standard for Health Care Facilities*. National Fire Protection Association 1 Batterymarch Park, Quincy, Massachusetts USA 02169
- ⁹ SMACNA *Duct Cleanliness for New Construction Guidelines*, (2000), Chantilly, VA 20151.

(This annex is not part of this standard. It is merely informative and does not contain requirements necessary for conformance to the standard. It has not been processed according to the ANSI requirements for a standard and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ASHRAE or ANSI.)

INFORMATIVE ANNEX A

A1. O&M IN HEALTH CARE FACILITIES

The following operations and maintenance procedures are recommended for health care facilities.

A1.1 Operating Rooms. Each operating room should be tested for positive pressure semi-annually or on an effective preventative maintenance schedule. When HEPA filters are present within the diffuser of operating rooms, the filter should be replaced based on pressure drop.

A1.2 Protective Environment (PE) Rooms. PE rooms should remain under positive pressure with respect to all adjoining rooms whenever an immunocompromised patient is present. PE rooms should be tested for positive pressure daily when an immunocompromised patient is present. When HEPA filters are present within the diffuser of protective environment rooms, the filter should be replaced based on pressure drop.

A1.3 Airborne Infection Isolation (AII) Rooms. AII rooms should remain under negative pressure relative to all adjoining rooms whenever an infectious patient is present. They should be tested for negative pressure daily whenever an infectious patient is present.

A1.4 Filters. Final filters and filter frames should be visually inspected for pressure drop and for bypass monthly. Filters should be replaced based on pressure drop with filters that provide the efficiencies specified in Table 6-1.

A2. SPECIAL MAINTENANCE FOR HVAC UNITS

The following special maintenance procedures are recommended for health care facilities.

A2.1 Fan-Coil Unit and Heat Pumps. The fan-coil unit and heat pump filters serving patient rooms should be inspected monthly or on an effective preventative maintenance cycle for pressure drop and replaced when that pressure drop causes a reduction in air flow. Fan-coil unit and heat pump drain pans under cooling coils should be cleaned monthly, or on an effective preventative maintenance cycle.

A2.2 Fin-Tube Radiation Units, Induction Units and Convection Units. Fin-tube radiation units, induction units and convection units serving patient rooms should be cleaned quarterly, or on an effective preventative maintenance cycle.

A2.3 Fan-Powered Terminal Units. Fan-powered terminal unit filters serving patient rooms should be inspected monthly or on an effective preventative maintenance cycle for pressure drop and replaced when the pressure drop causes a reduction in air flow.

(This annex is not part of this standard. It is merely informative and does not contain requirements necessary for conformance to the standard. It has not been processed according to the ANSI requirements for a standard and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ASHRAE or ANSI.)

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NOTICE

INSTRUCTIONS FOR SUBMITTING A PROPOSED CHANGE TO THIS STANDARD UNDER CONTINUOUS MAINTENANCE

This standard is maintained under continuous maintenance procedures by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the standard. SSPC consideration will be given to proposed changes within 13 months of receipt by the manager of standards (MOS).

Proposed changes must be submitted to the MOS in the latest published format available from the MOS. However, the MOS may accept proposed changes in an earlier published format if the MOS concludes that the differences are immaterial to the proposed change submittal. If the MOS concludes that a current form must be utilized, the proposer may be given up to 20 additional days to resubmit the proposed changes in the current format.

ELECTRONIC PREPARATION/SUBMISSION OF FORM FOR PROPOSING CHANGES

An electronic version of each change, which must comply with the instructions in the Notice and the Form, is the preferred form of submittal to ASHRAE Headquarters at the address shown below. The electronic format facilitates both paper-based and computer-based processing. Submittal in paper form is acceptable. The following instructions apply to change proposals submitted in electronic form.

Use the appropriate file format for your word processor and save the file in either a recent version of Microsoft Word (preferred) or another commonly used word-processing program. Please save each change proposal file with a different name (for example, "prop01.doc," "prop02.doc," etc.). If supplemental background documents to support changes submitted are included, it is preferred that they also be in electronic form as word-processed or scanned documents.

ASHRAE will accept the following as equivalent to the signature required on the change submittal form to convey non-exclusive copyright:

Files attached to an e-mail:

Electronic signature on change submittal form
(as a picture; *.tif, or *.wpg).

Files on a CD:

Electronic signature on change submittal form
(as a picture; *.tif, or *.wpg) or a letter with submitter's
signature accompanying the CD or sent by facsimile
(single letter may cover all of proponent's proposed changes).

Submit an e-mail or a CD containing the change proposal files to:

Manager of Standards

ASHRAE

1791 Tullie Circle, NE

Atlanta, GA 30329-2305

E-mail: change.proposal@ashrae.org

(Alternatively, mail paper versions to ASHRAE address or fax to 404-321-5478.)

The form and instructions for electronic submittal may be obtained from the Standards section of ASHRAE's Home Page, www.ashrae.org, or by contacting a Standards Secretary, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305.
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FORM FOR SUBMITTAL OF PROPOSED CHANGE TO AN ASHRAE STANDARD UNDER CONTINUOUS MAINTENANCE

NOTE: Use a separate form for each comment. Submittals (Microsoft Word preferred) may be attached to e-mail (preferred), submitted on a CD, or submitted in paper by mail or fax to ASHRAE, Manager of Standards, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: change.proposal@ashrae.org. Fax: +1-404/321-5478.

1. Submitter:

Affiliation:

Address: City: State: Zip: Country:

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Submitter's signature: _____ Date: _____

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2. Number and year of standard:

3. Page number and clause (section), subclause, or paragraph number:

4. I propose to: ☐ Change to read as follows ☐ Delete and substitute as follows
(check one) ☐ Add new text as follows ☐ Delete without substitution

Use underscores to show material to be added (added) and strike through material to be deleted (~~deleted~~). Use additional pages if needed.

5. Proposed change:

6. Reason and substantiation:

7. Will the proposed change increase the cost of engineering or construction? If yes, provide a brief explanation as to why the increase is justified.

☐ Check if additional pages are attached. Number of additional pages: _____

☐ Check if attachments or referenced materials cited in this proposal accompany this proposed change. Please verify that all attachments and references are relevant, current, and clearly labeled to avoid processing and review delays. Please list your attachments here:

**POLICY STATEMENT DEFINING ASHRAE'S CONCERN
FOR THE ENVIRONMENTAL IMPACT OF ITS ACTIVITIES**

ASHRAE is concerned with the impact of its members' activities on both the indoor and outdoor environment. ASHRAE's members will strive to minimize any possible deleterious effect on the indoor and outdoor environment of the systems and components in their responsibility while maximizing the beneficial effects these systems provide, consistent with accepted standards and the practical state of the art.

ASHRAE's short-range goal is to ensure that the systems and components within its scope do not impact the indoor and outdoor environment to a greater extent than specified by the standards and guidelines as established by itself and other responsible bodies.

As an ongoing goal, ASHRAE will, through its Standards Committee and extensive technical committee structure, continue to generate up-to-date standards and guidelines where appropriate and adopt, recommend, and promote those new and revised standards developed by other responsible organizations.

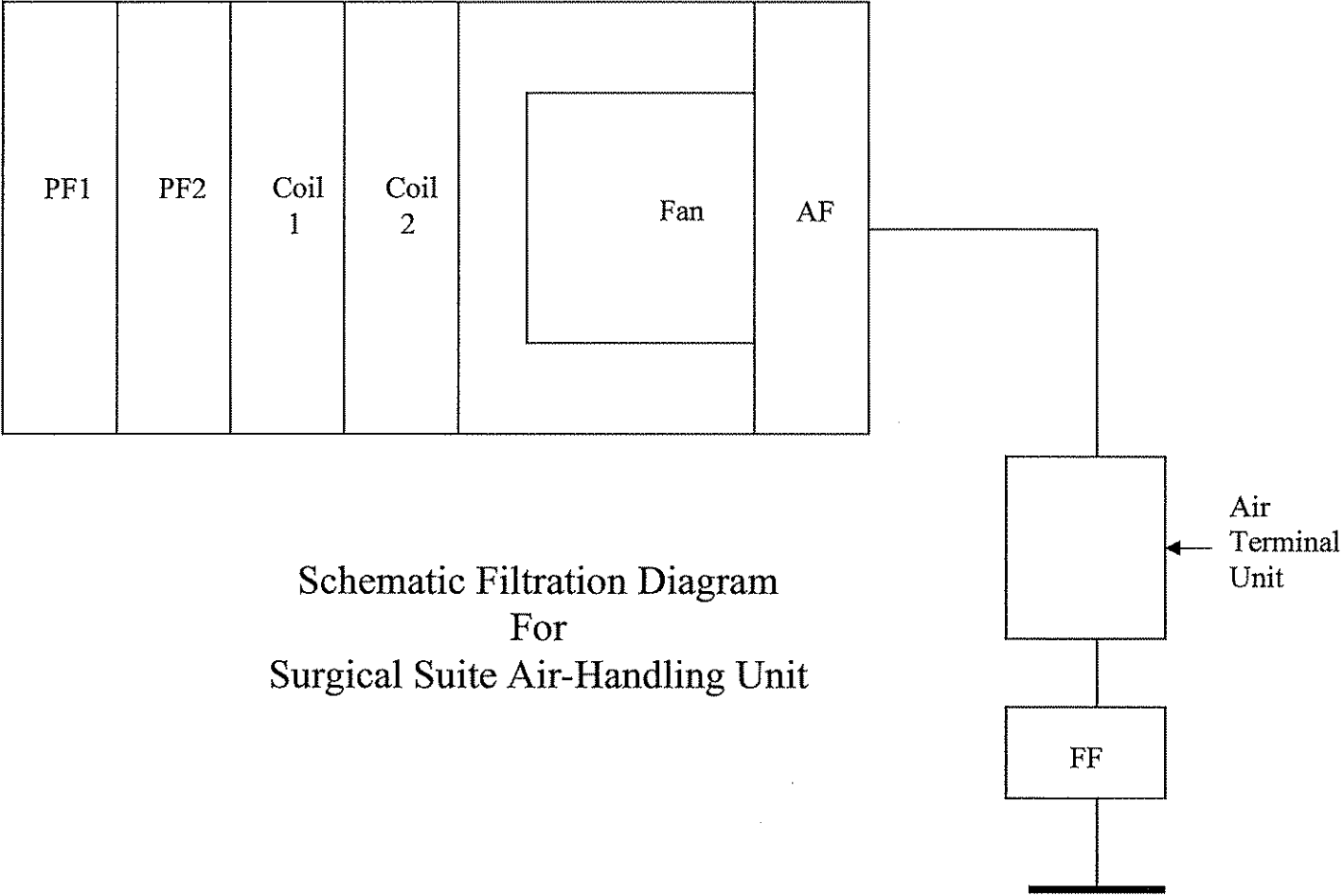
Through its *Handbook*, appropriate chapters will contain up-to-date standards and design considerations as the material is systematically revised.

ASHRAE will take the lead with respect to dissemination of environmental information of its primary interest and will seek out and disseminate information from other responsible organizations that is pertinent, as guides to updating standards and guidelines.

The effects of the design and selection of equipment and systems will be considered within the scope of the system's intended use and expected misuse. The disposal of hazardous materials, if any, will also be considered.

ASHRAE's primary concern for environmental impact will be at the site where equipment within ASHRAE's scope operates. However, energy source selection and the possible environmental impact due to the energy source and energy transportation will be considered where possible. Recommendations concerning energy source selection should be made by its members.

Filter Schedule - Surgical Suite Air-Handling Unit						
Filter	Application	Location	Type	Particle Size	ASHRAE 52.1 Efficiency	MERV Value
PF1	Pre-Filter - 1	Before Coils	2" - Flat Throw-Away	3.0 to 10.0 Microns	30 to 35%	7
PF2	Pre-Filter - 2	Before Coils	6" - Rigid Cartridge	1.0 to 3.0 Microns	50 to 55%	10
AF	After- Filter	After Coils	12" Rigid Cartridge	0.3 to 1.0 Micron	80 to 90%	13
FF	Final Filter	Terminal Filter	HEPA	0.3 Microns or Smaller	99.97%	17



Std. 52.2 Minimum Efficiency Reporting Value (MERV)	Approx. Std. 52.1 Results		Application Guidelines		
	Dust-Spot Efficiency	Arrestance	Typical Controlled Contaminant	Typical Applications and Limitations	Typical Air Filter/Cleaner Type
20	n/a	n/a	≤0.30 μm Particles	Cleanrooms	HEPA/ULPA Filters ≥99.999% efficiency on 0.1 to 0.2 μm particles, IEST Type F ≥99.999% efficiency on 0.3 μm particles, IEST Type D ≥99.99% efficiency on 0.3 μm particles, IEST Type C ≥99.97% efficiency on 0.3 μm particles, IEST Type A
19	n/a	n/a	Virus (unattached)	Radioactive materials	
18	n/a	n/a	Carbon dust	Pharmaceutical manufacturing	
17	n/a	n/a	Sea salt	Carcinogenic materials	
16	n/a	n/a	All combustion smoke	Orthopedic surgery	Bag Filters Nonsupported (flexible) microfine fiberglass or synthetic media. 12 to 36 in. deep, 6 to 12 pockets. Box Filters Rigid style cartridge filters 6 to 12 in. deep may use lofted (air-laid) or paper (wet-laid) media.
15	>95%	n/a	Radon progeny	Hospital inpatient care	
14	90 to 95%	>98%	0.3 to 1.0 μm Particles	General surgery	
13	80 to 90%	>98%	All bacteria	Smoking lounges	
12	70 to 75%	>95%	Most tobacco smoke	Superior commercial buildings	Bag Filters Nonsupported (flexible) microfine fiberglass or synthetic media. 12 to 36 in. deep, 6 to 12 pockets. Box Filters Rigid style cartridge filters 6 to 12 in. deep may use lofted (air-laid) or paper (wet-laid) media.
11	60 to 65%	>95%	Droplet nuclei (sneeze)	Hospital laboratories	
10	50 to 55%	>95%	Cooking oil		
9	40 to 45%	>90%	Most smoke		
8	30 to 35%	>90%	Insecticide dust	Commercial buildings Better residential Industrial workplaces Paint booth inlet air	Pleated Filters Disposable, extended-surface, 1 to 5 in. thick with cotton/polyester blend media, cardboard frame. Cartridge Filters Graded-density viscous-coated cube or pocket filters, synthetic media Throwaway Disposable synthetic media panel filters
7	25 to 30%	>90%	Copier toner		
6	<20%	85 to 90%	Most face powder		
5	<20%	80 to 85%	Most paint pigments		
4	<20%	75 to 80%	1.0 to 3.0 μm Particles	Minimum filtration Residential Window air conditioners	Throwaway Disposable fiberglass or synthetic panel filters Washable Aluminum mesh, latex coated animal hair, or foam rubber panel filters Electrostatic Self-charging (passive) woven polycarbonate panel filter
3	<20%	70 to 75%	Legionella		
2	<20%	65 to 70%	Humidifier dust		
1	<20%	<65%	Lead dust		

Note: MERV for non-HEPA/ULPA filters also includes test airflow rate, but it is not shown here because it is of no significance for the purposes of this table.

Where high-efficiency filters protect critical areas such as cleanrooms, it is important that the filters be installed as close to the room as possible to prevent pickup of particles between the filters and the outlet. The ultimate is the unidirectional flow room, in which the entire ceiling or one entire wall becomes the final filter bank.

Published performance data for all air filters are based on straight-through unrestricted airflow. Filters should be installed so that the face area is at right angles to the airflow whenever possible. Eddy currents and dead air spaces should be avoided; air should be distributed uniformly over the entire filter surface using baffles, diffusers, or air blenders, if necessary. Filters are sometimes damaged if higher-than-normal air velocities impinge directly on the face of the filter.

Failure of air filter installations to give satisfactory results can, in most cases, be traced to faulty installation, improper maintenance, or both. The most important requirements of a satisfactory and efficiently operating air filter installation are as follows:

- The filter must be of ample capacity for the amount of air and dust load it is expected to handle. An overload of 10 to 15% is regarded as the maximum allowable. When air volume is subject to future increase, a larger filter bank should be installed initially.
- The filter must be suited to the operating conditions, such as degree of air cleanliness required, amount of dust in the entering air, type of duty, allowable pressure drop, operating temperature, and maintenance facilities.

The following recommendations apply to filters installed with central fan systems:

- Duct connections to and from the filter should change size or shape gradually to ensure even air distribution over the entire filter area.
- The filter should be placed far enough from the fan to prevent or reduce reentrainment of particles, especially during start/stop cycles.