



STANDARD

ANSI/ASHRAE Standard 62.1-2007
(Supersedes ANSI/ASHRAE Standard 62.1-2004)
Includes ANSI/ASHRAE Addenda listed in Appendix I

Ventilation for Acceptable Indoor Air Quality

See Appendix I for approval dates by the ASHRAE Standards Committee the ASHRAE Board of Directors, and the American National Standards Institute.

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NOTE

Approved addenda, errata, or interpretations for this standard can be downloaded free of charge from the ASHRAE Web site at www.ashrae.org/technology.

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FOREWORD

ANSI/ASHRAE Standard 62.1-2007 is the latest edition of Standard 62. The 2007 edition combines Standard 62.1-2004 and the eight approved and published addenda to the 2004 edition, thereby providing an easy-to-use consolidated standard. Specific information on the content of each addendum and approval dates for each addendum are included in Informative Appendix I at the end of this standard.

First published in 1973, Standard 62.1 is now updated on a regular basis using ASHRAE's continuous maintenance procedures. According to these procedures, Standard 62.1 is continuously revised by addenda that are publicly reviewed, approved by ASHRAE and ANSI, and published in a supplement approximately 18 months after each new edition of the standard, or in a new, complete edition of the standard, published every three years.

Standard 62.1 has undergone some key changes over the years, reflecting the ever-expanding body of knowledge, experience, and research related to ventilation and air quality. While the purpose of the standard has remained consistent—to specify minimum ventilation rates and other measures intended to provide indoor air quality that is acceptable to human occupants and that minimizes adverse health effects—the means of achieving this goal have evolved. In its first edition the standard adopted a prescriptive approach to ventilation by specifying both minimum and recommended outdoor airflow rates to obtain acceptable indoor air quality for a variety of indoor spaces. In its 1981 edition, the standard reduced minimum outdoor airflow rates and introduced an alternative performance-based approach, the Indoor Air Quality (IAQ) Procedure, which allowed for the calculation of the amount of outdoor air necessary to maintain the levels of indoor air contaminants below recommended limits. Today the standard still retains the two procedures for ventilation design, the IAQ Procedure and the Ventilation Rate Procedure.

In its 1989 edition, and in response to a growing number of buildings with apparent indoor air quality problems, the standard increased minimum outdoor airflow rates significantly and introduced a requirement for finding outdoor air intake flow requirements for multiple-zone, recirculating systems. The 1999 and 2001 editions made several minor changes and clarifications that did not impact the minimum required outdoor airflow rates. In its 2004 edition—the last time the standard was published in its entirety—the standard modified the IAQ Procedure to improve enforceability, but more significantly, it modified the Ventilation Rate Procedure, changing both the minimum outdoor airflow rates and the procedures for calculating both zone-level and system-level outdoor airflow rates.

The 2007 edition of the standard updates, revises and improves it in several ways, without changing minimum outdoor airflow rates. The standard:

- *Clarifies dehumidification analysis requirements in Section 5.10, and offers exceptions to the 65% RH limit requirement and to the net-positive intake-airflow requirement (Addendum 62.1a).*
- *Corrects occupant category inconsistencies among Tables 5-2, 6-1, and 6-4, and provides additional information for several occupancy categories (Addendum 62.1b).*
- *Updates references and clarifies the text in Informative Appendix B, particularly as related to subjective evaluation of air quality (Addendum 62.1c).*
- *Updates the information presented in Table 4-1, to be consistent with the U.S. EPA National Ambient Air Quality Standards (NAAQS) as published at the time the addendum was approved, adding PM 2.5 as a criteria pollutant and adding the eight-hour standard for ozone (Addendum 62.1d).*
- *Includes a new informative appendix, Appendix H, which summarizes the documentation requirements in the body of the standard thus providing a single point of reference for users (Addendum 62.1e).*
- *Updates the purpose and scope of the standard to make them consistent with changes that have already been incorporated into the body of the standard. Specifically, it: excludes single-family houses and multiple-family structures of three or fewer stories from the scope, removes specific minimum outdoor airflow rates for areas that contain smoking or environmental tobacco smoke (ETS), and excludes thermal comfort requirements (Addendum 62.1f).*
- *Requires proper design for buildings that contain both ETS and ETS-free areas, by requiring (briefly): classification of areas based on expected presence of ETS, pressurization of ETS-free areas, separation of ETS and ETS-free areas, and cautionary signage for ETS-areas (Addendum 62.1g).*
- *Adds requirements for residential spaces in buildings with more than three stories to Table 6-1, and deletes Tables E-2 and E-3 from Appendix E, which provided ventilation requirements for residences and vehicles (Addendum 62.1h).*

For more specific information on these changes and on other revisions made to the standard by other addenda, refer to Informative Appendix I at the end of this standard. Users of the standard are encouraged to use the continuous maintenance procedure to suggest changes for further improvements. A form for submitting change proposals is included in the back of this edition. The project committee for Standard 62.1 will take formal action on all change proposals received.

1. PURPOSE

1.1 The purpose of this standard is to specify minimum ventilation rates and other measures intended to provide indoor

air quality that is acceptable to human occupants and that minimizes adverse health effects.

1.2 This standard is intended for regulatory application to new buildings, additions to existing buildings, and those changes to existing buildings that are identified in the body of the standard.

1.3 This standard is intended to be used to guide the improvement of indoor air quality in existing buildings.

2. SCOPE

2.1 This standard applies to all spaces intended for human occupancy except those within single-family houses, multi-family structures of three stories or fewer above grade, vehicles, and aircraft.

2.2 This standard defines requirements for ventilation and air-cleaning system design, installation, commissioning, and operation and maintenance.

2.3 Additional requirements for laboratory, industrial, health care, and other spaces may be dictated by workplace and other standards, as well as by the processes occurring within the space.

2.4 Although the standard may be applied to both new and existing buildings, the provisions of this standard are not intended to be applied retroactively when the standard is used as a mandatory regulation or code.

2.5 This standard does not prescribe specific ventilation rate requirements for spaces that contain smoking or that do not meet the requirements in the standard for separation from spaces that contain smoking.

2.6 Ventilation requirements of this standard are based on chemical, physical, and biological contaminants that can affect air quality.

2.7 Consideration or control of thermal comfort is not included.

2.8 This standard contains requirements, in addition to ventilation, related to certain sources, including outdoor air, construction processes, moisture, and biological growth.

2.9 Acceptable indoor air quality may not be achieved in all buildings meeting the requirements of this standard for one or more of the following reasons:

- because of the diversity of sources and contaminants in indoor air;
- because of the many other factors that may affect occupant perception and acceptance of indoor air quality, such as air temperature, humidity, noise, lighting, and psychological stress;
- because of the range of susceptibility in the population; and
- because outdoor air brought into the building may be unacceptable or may not be adequately cleaned.

3. DEFINITIONS (SEE FIGURE 3.1)

acceptable indoor air quality: air in which there are no known contaminants at harmful concentrations as determined by cognizant authorities and with which a substantial majority (80% or more) of the people exposed do not express dissatisfaction.

air-cleaning system: a device or combination of devices applied to reduce the concentration of airborne contaminants, such as microorganisms, dusts, fumes, respirable particles, other particulate matter, gases, and/or vapors in air.

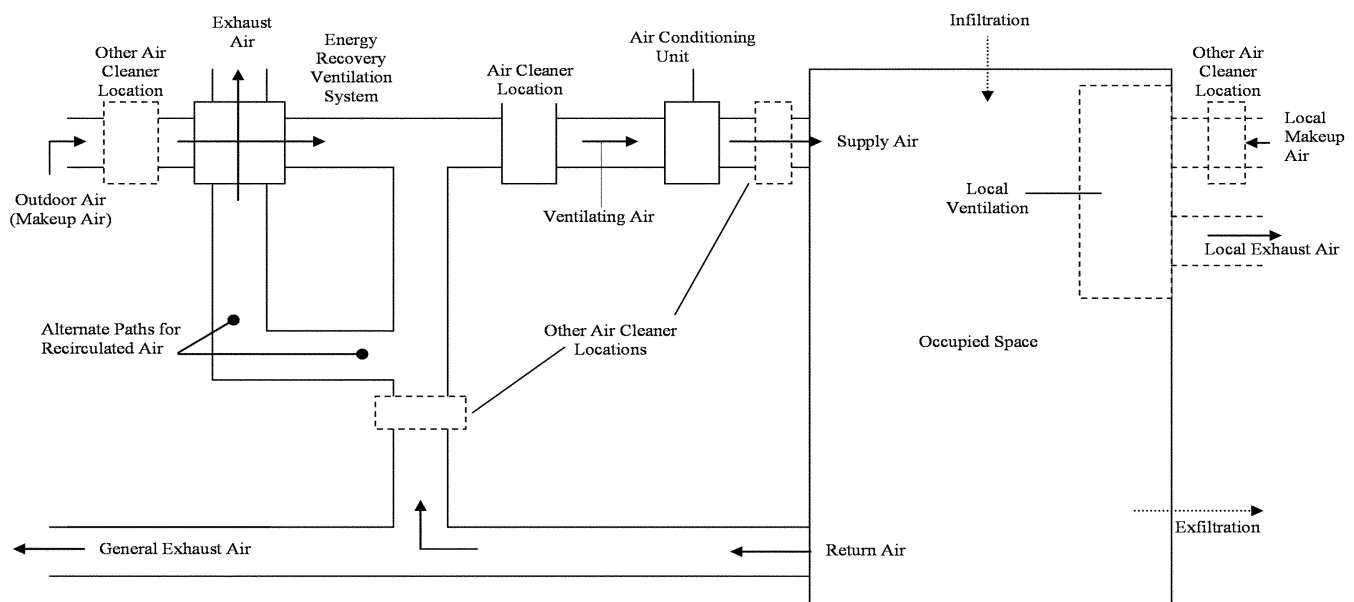


Figure 3.1 Ventilation system.

air conditioning: the process of treating air to meet the requirements of a conditioned space by controlling its temperature, humidity, cleanliness, and distribution.

air, ambient: the air surrounding a building; the source of outdoor air brought into a building.

air, exhaust: air removed from a space and discharged to outside the building by means of mechanical or natural ventilation systems.

air, indoor: the air in an enclosed occupiable space.

air, makeup: any combination of outdoor and transfer air intended to replace exhaust air and exfiltration.

air, outdoor: ambient air that enters a building through a ventilation system, through intentional openings for natural ventilation, or by infiltration.

air, recirculated: air removed from a space and reused as supply air.

air, return: air removed from a space to be then recirculated or exhausted.

air, supply: air delivered by mechanical or natural ventilation to a space, composed of any combination of outdoor air, recirculated air, or transfer air.

air, transfer: air moved from one indoor space to another.

air, ventilation: that portion of supply air that is outdoor air plus any recirculated air that has been treated for the purpose of maintaining acceptable indoor air quality.

breathing zone: the region within an occupied space between planes 3 and 72 in. (75 and 1800 mm) above the floor and more than 2 ft (600 mm) from the walls or fixed air-conditioning equipment.

cognizant authority: an agency or organization that has the expertise and jurisdiction to establish and regulate concentration limits for airborne contaminants; or an agency or organization that is recognized as authoritative and has the scope and expertise to establish guidelines, limit values, or concentrations levels for airborne contaminants.

concentration: the quantity of one constituent dispersed in a defined amount of another.

conditioned space: that part of a building that is heated or cooled, or both, for the comfort of occupants.

contaminant: an unwanted airborne constituent that may reduce acceptability of the air.

energy recovery ventilation system: a device or combination of devices applied to provide the outdoor air for ventilation in which energy is transferred between the intake and exhaust airstreams.

environmental tobacco smoke (ETS): the “aged” and diluted combination of both side-stream smoke (smoke from the lit end of a cigarette or other tobacco product) and exhaled mainstream smoke (smoke that is exhaled by a smoker). ETS is commonly referred to as *secondhand smoke*.

ETS-free area: an area where no smoking occurs and that is separated from ETS areas according to the requirements of this standard.

Note: A no-smoking area is not necessarily an ETS-free area.

ETS area: spaces where smoking is permitted, as well as those not separated from spaces where smoking is permitted in accord with the requirements of Section 5 in this standard.

exfiltration: uncontrolled outward air leakage from conditioned spaces through unintentional openings in ceilings, floors, and walls to unconditioned spaces or the outdoors caused by pressure differences across these openings due to wind, inside-outside temperature differences (stack effect), and imbalances between supply and exhaust airflow rates.

industrial space: an indoor environment where the primary activity is production or manufacturing processes. The processes in these spaces may generate contaminants with characteristics and in quantities dictating that principles of worker safety and industrial hygiene be used to define contaminant control strategies, including ventilation. Also, the primary occupants of these spaces consist of the individuals involved in these processes.

infiltration: uncontrolled inward air leakage to conditioned spaces through unintentional openings in ceilings, floors, and walls from unconditioned spaces or the outdoors caused by the same pressure differences that induce exfiltration.

mechanical ventilation: ventilation provided by mechanically powered equipment, such as motor-driven fans and blowers, but not by devices such as wind-driven turbine ventilators and mechanically operated windows.

microorganism: a microscopic organism, especially a bacterium, fungus, or a protozoan.

natural ventilation: ventilation provided by thermal, wind, or diffusion effects through doors, windows, or other intentional openings in the building.

net occupiable space: the floor area of an occupiable space defined by the inside surfaces of its walls but excluding shafts, column enclosures, and other permanently enclosed, inaccessible, and unoccupiable areas. Obstructions in the space such as furnishings, display or storage racks, and other obstructions, whether temporary or permanent, may not be deducted from the space area.

occupiable space: an enclosed space intended for human activities, excluding those spaces intended primarily for other purposes, such as storage rooms and equipment rooms, that are only occupied occasionally and for short periods of time.

odor: a quality of gases, liquids, or particles that stimulates the olfactory organ.

readily accessible: capable of being reached quickly for operation without requiring those for whom ready access is required to climb over or remove obstacles or to resort to portable ladders, chairs, or other climbing aids.

ventilation: the process of supplying air to or removing air from a space for the purpose of controlling air contaminant levels, humidity, or temperature within the space.

volume, space: the total volume of an occupiable space enclosed by the building envelope, plus that of any spaces permanently open to the occupiable space, such as a ceiling attic used as a ceiling return plenum.

zone: one occupied space or several occupied spaces with similar occupancy category (see Table 6-1), *occupant density*, *zone air distribution effectiveness* (see Section 6.2.2.2), and *zone primary airflow* (see Section 6.2.5.1) per unit area.

Note: A ventilation zone is not necessarily an independent thermal control zone; however, spaces that can be combined for load calculations can often be combined into a single zone for ventilation calculations.

4. OUTDOOR AIR QUALITY

Outdoor air quality shall be investigated in accordance with Sections 4.1 and 4.2 prior to completion of ventilation system design. The results of this investigation shall be documented in accordance with Section 4.3.

4.1 Regional Air Quality. The status of compliance with national ambient air quality standards shall be determined for the geographic area of the building site. In the United States, compliance status shall be either in “attainment” or “non-attainment” with the National Ambient Air Quality Standards (NAAQS)¹ for each pollutant shown in Table 4-1. In the United States, areas with no EPA compliance status designation shall be considered “attainment” areas.

4.2 Local Air Quality. An observational survey of the building site and its immediate surroundings shall be conducted during hours the building is expected to be normally occupied to identify local contaminants from surrounding facilities that may be of concern if allowed to enter the building.

4.3 Documentation. Documentation of the outdoor air quality investigation shall be reviewed with building owners or their representative and shall include the following:

1. Regional air quality compliance status.

Note: Regional outdoor air quality compliance status for the United States is available from the U.S. Environmental Protection Agency located under www.epa.gov.

2. Local survey information, which may include the following:

- a. Date of observations
- b. Time of observations
- c. Area surveyed
- d. Description of nearby facilities
- e. Observation of odors or irritants
- f. Description of visible plumes or air contaminants
- g. Description of nearby sources of vehicle exhaust
- h. Direction of prevailing winds

3. Conclusions regarding the acceptability of outdoor air quality based on consideration of information from investigation.

5. SYSTEMS AND EQUIPMENT

5.1 Natural Ventilation. Use of natural ventilation systems designed in accordance with this section shall be permitted in lieu of or in conjunction with mechanical ventilation systems.

Exception: An engineered natural ventilation system when approved by the authority having jurisdiction need not meet the requirements of Sections 5.1.1 and 5.1.2.

5.1.1 Location and Size of Openings. Naturally ventilated spaces shall be permanently open to and within 8 m (25 ft) of operable wall or roof openings to the outdoors, the openable area of which is a minimum of 4% of the net occupiable floor area. Where openings are covered with louvers or otherwise obstructed, openable area shall be based on the free unobstructed area through the opening. Where interior spaces without direct openings to the outdoors are ventilated through adjoining rooms, the opening between rooms shall be permanently unobstructed and have a free area of not less than 8% of the area of the interior room nor less than 25 ft² (2.3 m²).

5.1.2 Control and Accessibility. The means to open required operable openings shall be readily accessible to building occupants whenever the space is occupied.

TABLE 4-1 National Primary Ambient Air Quality Standards for Outdoor Air as Set by the U.S. Environmental Protection Agency

Contaminant	Long Term			Short Term		
	Concentration Averaging			Concentration Averaging		
	µg/m ³	ppm		µg/m ³	ppm	
Sulfur dioxide	80	0.03	1 year ^b	365	0.14	24 hours ^a
Particles (PM 10)	50	—	1 year ^{b,g}	150	—	24 hours ^a
Particles (PM 2.5)	15	—	1 year ^{b,e}	65	—	24 hours ^f
Carbon monoxide				40,000	35	1 hour ^a
				10,000	9	8 hours ^a
Oxidants (ozone)					0.08	8 hours ^c
					0.12	1 hour ^h
Nitrogen dioxide	100	0.053	1 year ^b			
Lead	1.5	—	3 months ^d			

^aNot to be exceeded more than once per year.

^bAnnual arithmetic mean.

^cThe three-year average of the fourth-highest daily maximum eight-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.08 ppm.

^dThree-month period is a calendar quarter.

^eThree-year average of the annual arithmetic mean.

^fThe three-year average of the 98th percentile of 24-hour concentrations.

^gThe annual arithmetic mean.

^h(1) The standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is ≤1, as determined by Appendix H (40 CFR 50). (2) The one-hour NAAQS will no longer apply to an area one year after the effective date of the designation of that area for the eight-hour ozone NAAQS. The effective designation date for most areas is June 15, 2004 (40 CFR 50.9; see Federal Register of April 30, 2004 [69 FR 23996]).

5.2 Ventilation Air Distribution. Ventilating systems shall be designed in accordance with the following.

5.2.1 Designing for Air Balancing. The ventilation air distribution system shall be provided with means to adjust the system to achieve at least the minimum ventilation airflow as required by Section 6 under any load condition.

5.2.2 Plenum Systems. When the ceiling or floor plenum is used both to recirculate return air and to distribute ventilation air to ceiling-mounted or floor-mounted terminal units, the system shall be engineered such that each space is provided with its required minimum ventilation airflow.

Note: Direct connection of ventilation air ducts to ventilating terminal units is an alternate method of satisfying the intent of this requirement.

5.2.3 Documentation. The design documents shall specify minimum requirements for air balance testing or reference applicable national standards for measuring and balancing airflow. The design documentation shall state assumptions that were made in the design with respect to ventilation rates and air distribution.

5.3 Exhaust Duct Location. Exhaust ducts that convey potentially harmful contaminants shall be negatively pressurized relative to spaces through which they pass, so that exhaust air cannot leak into occupied spaces; supply, return, or outdoor air ducts; or plenums.

Exception: Exhaust ducts that are sealed in accordance with SMACNA Seal Class A.²

5.4 Ventilation System Controls. Mechanical ventilation systems shall include controls, manual or automatic, that enable the fan system to operate whenever the spaces served are occupied. The system shall be designed to maintain the

minimum outdoor airflow as required by Section 6 under any load condition.

Note: VAV systems with fixed outdoor air damper positions must comply with this requirement at minimum supply airflow.

5.5 Airstream Surfaces. All airstream surfaces in equipment and ducts in the heating, ventilating, and air-conditioning system shall be designed and constructed in accordance with the following requirements.

5.5.1 Resistance to Mold Growth. Material surfaces shall be determined to be resistant to mold growth in accordance with a standardized test method, such as the “Mold Growth and Humidity Test” in UL 181,¹⁰ ASTM C 1338,¹¹ or comparable test methods.

Exception: Sheet metal surfaces and metal fasteners.

Note: Even with this resistance, any airstream surface that is continuously wetted is still subject to microbial growth.

5.5.2 Resistance to Erosion. Airstream surface materials shall be evaluated in accordance with the “Erosion Test” in UL 181¹⁰ and shall not break away, crack, peel, flake off, or show evidence of delamination or continued erosion under test conditions.

Exception: Sheet metal surfaces and metal fasteners.

5.6 Outdoor Air Intakes. Ventilation system outdoor intakes shall be designed in accordance with the following.

5.6.1 Location. Outdoor air intakes, including doors and windows that are required as part of a natural ventilation system, shall be located such that the shortest distance from the intake to any specific potential outdoor contaminant source shall be equal to or greater than the separation distance listed in Table 5-1.

TABLE 5-1 Air Intake Minimum Separation Distance

Object	Minimum Distance, ft (m)
Significantly contaminated exhaust (Note 1)	15 (5)
Noxious or dangerous exhaust (Notes 2 and 3)	30 (10)
Vents, chimneys, and flues from combustion appliances and equipment (Note 4)	15 (5)
Garage entry, automobile loading area, or drive-in queue (Note 5)	15 (5)
Truck loading area or dock, bus parking/idling area (Note 5)	25 (7.5)
Driveway, street, or parking place (Note 5)	5 (1.5)
Thoroughfare with high traffic volume	25 (7.5)
Roof, landscaped grade, or other surface directly below intake (Notes 6 and 7)	1 (0.30)
Garbage storage/pick-up area, dumpsters	15 (5)
Cooling tower intake or basin	15 (5)
Cooling tower exhaust	25 (7.5)

Note 1: Significantly contaminated exhaust is exhaust air with significant contaminant concentration, significant sensory-irritation intensity, or offensive odor.

Note 2: Laboratory fume hood exhaust air outlets shall be in compliance with NFPA 45-1991³ and ANSI/AIHA Z9.5-1992.⁴

Note 3: Noxious or dangerous exhaust is exhaust air with highly objectionable fumes or gases and/or exhaust air with potentially dangerous particles, bioaerosols, or gases at concentrations high enough to be considered harmful. Information on separation criteria for industrial environments can be found in the ACGIH Industrial Ventilation Manual⁵ and in the ASHRAE Handbook—HVAC Applications.⁶

Note 4: Shorter separation distances are permitted when determined in accordance with (a) Chapter 7 of ANSI Z223.1/NFPA 54-2002⁷ for fuel gas burning appliances and equipment, (b) Chapter 6 of NFPA 31-2001⁸ for oil burning appliances and equipment, or (c) Chapter 7 of NFPA 211-2003⁹ for other combustion appliances and equipment.

Note 5: Distance measured to closest place that vehicle exhaust is likely to be located.

Note 6: No minimum separation distance applies to surfaces that are sloped more than 45 degrees from horizontal or that are less than 1 in. (3 cm) wide.

Note 7: Where snow accumulation is expected, distance listed shall be increased by the expected average snow depth.

Exception: Other minimum separation distances are acceptable if it can be shown that an equivalent or lesser rate of introduction of outdoor air contaminants will be attained.

Note: Appendix F presents an acceptable alternative method of determining the minimum separation distance.

5.6.2 Rain Entrainment. Outdoor air intakes that are part of the mechanical ventilation system shall be designed to manage rain entrainment in accordance with any one of the following:

- a. Limit water penetration through the intake to $0.07 \text{ oz/ft}^2\cdot\text{h}$ ($21.5 \text{ g/m}^2\cdot\text{h}$) of inlet area when tested using the rain test apparatus described in Section 58 of UL 1995.¹²
- b. Select louvers that limit water penetration to a maximum of 0.01 oz/ft^2 (3 g/m^2) of louver free area at the maximum intake velocity. This water penetration rate shall be determined for a minimum 15-minute test duration when subjected to a water flow rate of 0.25 gal/min (16 mL/s) as described under the Water Penetration Test in AMCA 500-L-99¹³ or equivalent. Manage the water that penetrates the louver by providing a drainage area and/or moisture removal devices.
- c. Select louvers that restrict wind-driven rain penetration to less than $2.36 \text{ oz/ft}^2\cdot\text{h}$ ($721 \text{ g/m}^2\cdot\text{h}$) when subjected to a simulated rainfall of 3 in. (75 mm) per hour and a 29 mph (13 m/s) wind velocity at the design outdoor air intake rate with the air velocity calculated based on the louver face area.

Note: This performance corresponds to Class A (99% effectiveness) when rated according to AMCA 511-99¹⁴ and tested per AMCA 500-L-99.¹³

- d. Use rain hoods sized for no more than 500 fpm (2.5 m/s) face velocity with a downward-facing intake such that all intake air passes upward through a horizontal plane that intersects the solid surfaces of the hood before entering the system.
- e. Manage the water that penetrates the intake opening by providing a drainage area and/or moisture removal devices.

5.6.3 Rain Intrusion. Air-handling and distribution equipment mounted outdoors shall be designed to prevent rain intrusion into the airstream when tested at design airflow and with no airflow, using the rain test apparatus described in Section 58 of UL 1995.¹²

5.6.4 Snow Entrainment. Where climate dictates, outdoor air intakes that are part of the mechanical ventilation system shall be designed to manage melted snow blown or drawn into the system as follows:

- a. Suitable access doors to permit cleaning shall be provided.
- b. Outdoor air ductwork or plenums shall pitch to drains designed in accordance with the requirements of Section 5.11.

5.6.5 Bird Screens. Outdoor air intakes shall include a screening device designed to prevent penetration by a 0.5 in. (13 mm) diameter probe. The screening device material shall be corrosion resistant. The screening device shall be located, or other measures shall be taken, to prevent bird nesting within the outdoor air intake.

Note: Any horizontal surface may be subject to bird nesting.

5.7 Local Capture of Contaminants. The discharge from noncombustion equipment that captures the contaminants generated by the equipment shall be ducted directly to the outdoors.

Exception: Equipment specifically designed for discharge indoors in accordance with the manufacturer's recommendations.

5.8 Combustion Air. Fuel-burning appliances, both vented and unvented, shall be provided with sufficient air for combustion and adequate removal of combustion products, in accordance with manufacturer instructions. Products of combustion from vented appliances shall be vented directly outdoors.

5.9 Particulate Matter Removal. Particulate matter filters or air cleaners having a minimum efficiency reporting value (MERV) of not less than 6 when rated in accordance with ANSI/ASHRAE Standard 52.2¹⁵ shall be provided upstream of all cooling coils or other devices with wetted surfaces through which air is supplied to an occupiable space.

5.10 Dehumidification Systems. Mechanical air-conditioning systems with dehumidification capability shall be designed to comply with the following.

5.10.1 Relative Humidity. Occupied space relative humidity shall be limited to 65% or less when system performance is analyzed with outdoor air at the dehumidification design condition (that is, design dew point and mean coincident dry-bulb temperatures) and with the space interior loads (both sensible and latent) at cooling design values and space solar loads at zero.

Note: System configuration and/or climatic conditions may adequately limit space relative humidity at these conditions without additional humidity-control devices. The specified conditions challenge the system dehumidification performance with high outdoor latent load and low space sensible heat ratio.

Exception: Spaces where process or occupancy requirements dictate higher humidity conditions, such as kitchens, hot tub rooms that contain heated standing water, refrigerated or frozen storage rooms and ice rinks, and/or spaces designed and constructed to manage moisture, such as shower rooms, pools, and spas.

5.10.2 Exfiltration. For a building, the design minimum outdoor air intake shall be greater than the design maximum exhaust airflow when the mechanical air-conditioning systems are dehumidifying.

Exception: Where excess exhaust is required by process considerations and approved by the authority having jurisdiction, such as in certain industrial facilities.

Note: Although individual zones within a building may be neutral or negative with respect to outdoors or to other zones, net positive mechanical intake airflow for the building as a whole reduces infiltration of untreated outdoor air.

5.11 Drain Pans. Drain pans, including their outlets and seals, shall be designed and constructed in accordance with this section.

5.11.1 Drain Pan Slope. Pans intended to collect and drain liquid water shall be sloped at least 0.125 in. per foot (10 mm per meter) from the horizontal toward the drain outlet or shall be otherwise designed to ensure that water drains freely from the pan whether the fan is on or off.

5.11.2 Drain Outlet. The drain pan outlet shall be located at the lowest point(s) of the drain pan and shall be of sufficient diameter to preclude drain pan overflow under any normally expected operating condition.

5.11.3 Drain Seal. For configurations that result in negative static pressure at the drain pan relative to the drain outlet (such as a draw-through unit), the drain line shall include a P-trap or other sealing device designed to maintain a seal against ingestion of ambient air while allowing complete drainage of the drain pan under any normally expected operating condition, whether the fan is on or off.

5.11.4 Pan Size. The drain pan shall be located under the water-producing device. Drain pan width shall be sufficient to collect water droplets across the entire width of the water-producing device or assembly. For horizontal airflow configurations, the drain pan length shall begin at the leading face or edge of the water-producing device or assembly and extend downstream from the leaving face or edge to a distance of either:

- a. one half of the installed vertical dimension of the water-producing device or assembly, or
- b. as necessary to limit water droplet carryover beyond the drain pan to $0.0044 \text{ oz per ft}^2$ (1.5 mL per m^2) of face area per hour under peak sensible and peak dew point design conditions, considering both latent load and coil face velocity.

5.12 Finned-Tube Coils and Heat Exchangers

5.12.1 Drain Pans. A drain pan in accordance with Section 5.11 shall be provided beneath all dehumidifying cooling coil assemblies and all condensate-producing heat exchangers.

5.12.2 Finned-Tube Coil Selection for Cleaning. Individual finned-tube coils or multiple finned-tube coils in series without adequate intervening access space(s) of at least 18 in. (457 mm) shall be selected to result in no more than 0.75 in. w.c. (187 Pa) combined pressure drop when dry coil face velocity is 500 fpm (2.54 m/s).

Exception: When clear and complete instructions for access and cleaning of both upstream and downstream coil surfaces are provided.

5.13 Humidifiers and Water-Spray Systems. Steam and direct evaporation humidifiers, air washers, and other water-spray systems shall be designed in accordance with this section.

5.13.1 Water Quality. Water shall originate directly from a potable source or from a source with equal or better water quality.

5.13.2 Obstructions. Air cleaners or ductwork obstructions, such as turning vanes, volume dampers, and duct offsets greater than 15 degrees, that are installed downstream of humidifiers or water spray systems shall be located a distance equal to or greater than the absorption distance recommended by the humidifier or water spray system manufacturer.

Exception: Equipment such as eliminators, coils, or evaporative media may be located within the absorption distance recommended by the manufacturer, provided a drain pan complying with the requirements of Section 5.11 is used to capture and remove any water that may drop out of the airstream due to impingement on these obstructions.

5.14 Access for Inspection, Cleaning, and Maintenance

5.14.1 Equipment Clearance. Ventilation equipment shall be installed with sufficient working space for inspection and routine maintenance (e.g., filter replacement and fan belt adjustment and replacement).

5.14.2 Ventilation Equipment Access. Access doors, panels, or other means shall be provided and sized to allow convenient and unobstructed access sufficient to inspect, maintain, and calibrate all ventilation system components for which routine inspection, maintenance, or calibration is necessary. Ventilation system components comprise, for example, air-handling units, fan-coil units, water-source heat pumps, other terminal units, controllers, and sensors.

5.14.3 Air Distribution System. Access doors, panels, or other means shall be provided in ventilation equipment, ductwork, and plenums, located and sized to allow convenient and unobstructed access for inspection, cleaning, and routine maintenance of the following:

- a. Outdoor air intake areaways or plenums
- b. Mixed air plenums
- c. Upstream surface of each heating, cooling, and heat-recovery coil or coil assembly having a total of four rows or less
- d. Both upstream and downstream surface of each heating, cooling, and heat-recovery coil having a total of more than four rows and air washers, evaporative coolers, heat wheels, and other heat exchangers
- e. Air cleaners
- f. Drain pans and drain seals
- g. Fans
- h. Humidifiers

5.15 Building Envelope and Interior Surfaces. The building envelope and interior surfaces within the building envelope shall be designed in accordance with the following.