



STANDARD

ANSI/ASHRAE Standard 62.1-2010

(Supersedes ANSI/ASHRAE Standard 62.1-2007)

Includes ANSI/ASHRAE addenda listed in Appendix J

Ventilation for Acceptable Indoor Air Quality

See Appendix J 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 62.1-2010 is the latest edition of Standard 62.1. The 2010 edition combines Standard 62.1-2007 and the 20 approved and published addenda to the 2007 edition, thereby providing an easy-to-use consolidated standard. Specific information on the contents of each addendum and approval dates for each addendum are included in Informative Appendix J at the end of this standard.

First published in 1973 as Standard 62, 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 (VRP).

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 provided

some significant updates, but the changes primarily focused on usability and clarity.

The 2010 edition of the standard revises and improves it in several ways. A number of changes remove inconsistencies within the standard and improve clarity. Significant changes include:

- *Deletes Section 6.2.9, which had addressed ventilation in areas with smoking. Ventilation for such spaces is no longer covered by the standard.*
- *Provides minimum requirements to clarify when ventilation systems must be operated.*
- *Relocates natural ventilation requirements to a new Section 6.4, adding a prescriptive Natural Ventilation Procedure to the existing Ventilation Rate Procedure in Section 6.2 and IAQ Procedure in Section 6.3. The standard also now requires that most buildings designed to meet the natural ventilation requirements include a mechanical ventilation system designed to meet the VRP or IAQ Procedure requirements; mechanical system operation must be activated whenever conditions preclude operation of the natural ventilation system (e.g., due to thermal comfort, noise, security, or other issues).*
- *Relocates Table 6-4 and other requirements related to exhaust systems to a new Section 6.5, since exhaust requirements apply to all buildings, regardless of the procedure used to determine outdoor air intake flow rates.*
- *Revises the IAQ Procedure to make it more robust. In informative Appendix B, provides a table of volatile organic compounds that designers might want to consider as possible contaminants of concern. To encourage designers to consider “additivity” (a basic consideration in the prescriptive VRP) when applying the IAQ Procedure, some guidance from the ACGIH has been included in the informative text.*
- *Adds additional requirements related to the design of demand-controlled ventilation systems.*
- *Revises requirements for separation of outdoor air intakes from exhaust and relief air outlets by using Classes of Air already defined in the standard rather than descriptions of the air quality.*
- *Adds some occupancy categories to the ventilation rate table (Table 6-1) and revises ventilation rates for a few occupancy categories.*
- *Deletes ventilation requirements for health care spaces since they are now covered by ASHRAE/ASHE Standard 170-2008, Ventilation of Health Care Facilities.*
- *Adds minimum filtration requirements related to PM_{2.5}, and changes minimum air cleaning requirements related to ozone to reflect changes in the U.S. EPA's ozone reporting procedures. Table 4-1 is moved to an informative appendix to facilitate updates when the EPA makes changes to the NAAQS.*

For more specific information on these changes and on other revisions made to the standard by other addenda, refer to Informative Appendix J 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:

- a. because of the diversity of sources and contaminants in indoor air;

- b. 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;
- c. because of the range of susceptibility in the population; and
- d. 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.

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

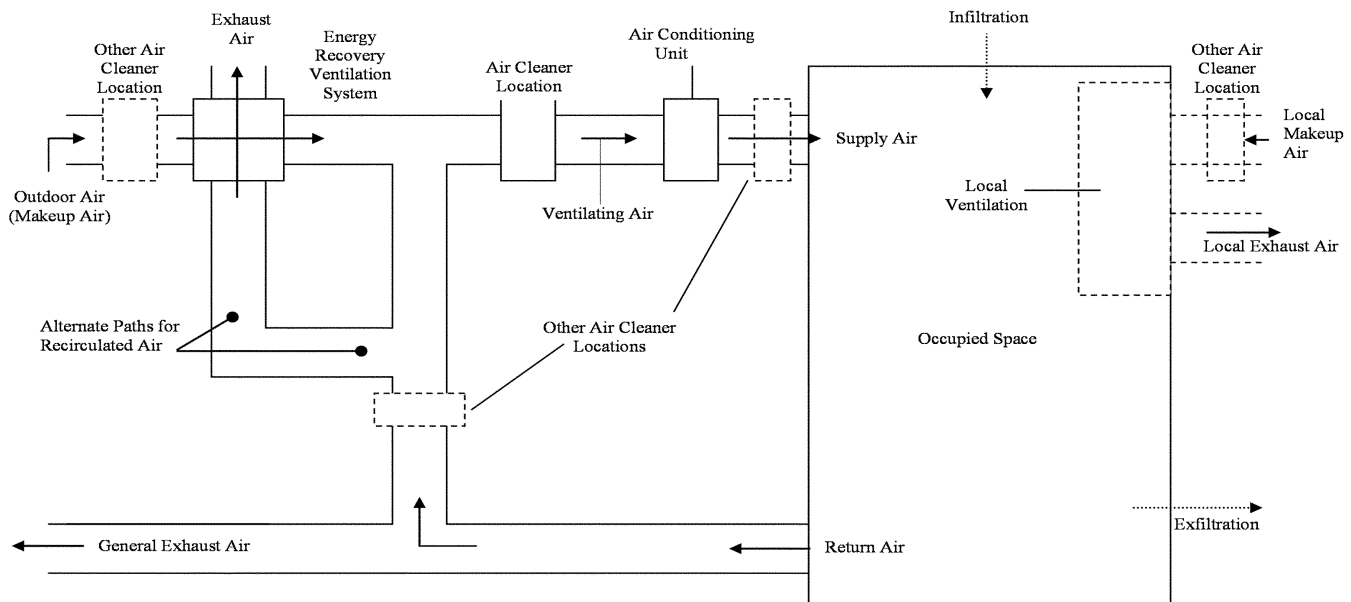


Figure 3.1 Ventilation system.

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.

demand-controlled ventilation (DCV): any means by which the breathing zone outdoor airflow (V_{bz}) can be varied to the occupied space or spaces based on the actual or estimated number of occupants and/or ventilation requirements of the occupied zone.

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 protozoan.

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

net occupiable area: 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, are considered to be part of the net occupiable area.

occupiable space: an enclosed space intended for human activities, excluding those spaces that are intended primarily for other purposes, such as storage rooms and equipment rooms, and 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.

ventilation zone: any indoor area that requires ventilation and consists of one or more occupiable 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 calculation purposes can often be combined into a single zone for ventilation calculations purposes.

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.

4.1.1 In the United States, compliance status shall be either in “attainment” or “non-attainment” with the *National Ambient Air Quality Standards* (NAAQS)¹. In the United States, areas with no EPA compliance status designation shall be considered “attainment” areas.

Note: The *National Ambient Air Quality Standards* (NAAQS) are shown in Informative Appendix I, Table I-1.

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 as a minimum:

a. 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.

b. Local survey information:

1. Date of observations
2. Time of observations
3. Site description
4. Description of facilities on site and on adjoining properties
5. Observation of odors or irritants
6. Observation of visible plumes or visible air contaminants
7. Description of sources of vehicle exhaust on site and on adjoining properties
8. Identification of potential contaminant sources on the site and from adjoining properties

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

5. SYSTEMS AND EQUIPMENT

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

5.1.1 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.

5.1.2 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: Systems with direct connection of ventilation air ducts to terminal units, for example, comply with this requirement.

5.1.3 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.

5.2 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

5.3 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 no less than the minimum outdoor airflow as required by Section 6 under any load condition.

Note: Variable Air Volume (VAV) systems with fixed outdoor air damper positions must comply with this requirement at minimum system primary airflow.

5.4 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.

5.4.1 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 181,³ ASTM C 1338,⁴ 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.

5.4.2 Resistance to Erosion. Airstream surface materials shall be evaluated in accordance with the “Erosion Test” in UL 181³ 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.

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

5.5.1 Location. Outdoor air intakes (including openings 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.

Exception: Other minimum separation distances shall be permitted, provided it can be shown analytically that an

equivalent or lesser rate of introduction of contaminants from outdoor sources will be attained.

Note: Appendix F presents an analytical method for determining the minimum separation distances based on dilution of outdoor contaminants.

5.5.2 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:

- Limit water penetration through the intake to 0.07 oz/ft²·h (21.5 g/m²·h) of inlet area when tested using the rain test apparatus described in Section 58 of UL 1995.¹²
- Select louvers that limit water penetration to a maximum of 0.01 oz/ft² (3 g/m²) 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-L¹³ or equivalent. Manage the water that penetrates the louver by providing a drainage area and/or moisture removal devices.
- Select louvers that restrict wind-driven rain penetration to less than 2.36 oz/ft²·h (721 g/m²·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 511¹⁴ and tested per AMCA 500-L.¹³

TABLE 5-1 Air Intake Minimum Separation Distance

Object	Minimum Distance, ft (m)
Class 2 air exhaust/relief outlet (Note 1)	10 (3)
Class 3 air exhaust/relief outlet (Note 1)	15 (5)
Class 4 air exhaust/relief outlet (Note 2)	30 (10)
Plumbing vents terminating less than 3 ft (1 m) above the level of the outdoor air intake	10 (3)
Plumbing vents terminating at least 3 ft (1 m) above the level of the outdoor air intake	3 (1)
Vents, chimneys, and flues from combustion appliances and equipment (Note 3)	15 (5)
Garage entry, automobile loading area, or drive-in queue (Note 4)	15 (5)
Truck loading area or dock, bus parking/idling area (Note 4)	25 (7.5)
Driveway, street, or parking place (Note 4)	5 (1.5)
Thoroughfare with high traffic volume	25 (7.5)
Roof, landscaped grade, or other surface directly below intake (Notes 5 and 6)	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: This requirements applies to the distance from the outdoor air intakes for one ventilation system to the exhaust/relief outlets for any other ventilation system.

Note 2: Minimum distance listed does not apply to laboratory fume hood exhaust air outlets. Separation criteria for fume hood exhaust shall be in compliance with NFPA 45⁵ and ANSI/IIHA Z9.5.⁶ Information on separation criteria for industrial environments can be found in the *ACGIH Industrial Ventilation Manual*⁷ and in the *ASHRAE Handbook—HVAC Applications*.⁸

Note 3: Shorter separation distances shall be permitted when determined in accordance with (a) ANSI Z223.1/NFPA 54⁹ for fuel gas burning appliances and equipment, (b) NFPA 31¹⁰ for oil burning appliances and equipment, or (c) NFPA 211¹¹ for other combustion appliances and equipment.

Note 4: Distance measured to closest place that vehicle exhaust is likely to be located.

Note 5: Shorter separation distance shall be permitted where outdoor surfaces are sloped more than 45 degrees from horizontal or that are less than 1 in. (3 cm) wide.

Note 6: Where snow accumulation is expected, the surface of the snow at the expected average snow depth constitutes the “other surface directly below intake.”

- 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.

5.5.3 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

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

- a. Suitable access doors to permit cleaning of wetted surfaces shall be provided.
- b. Outdoor air ductwork or plenums shall pitch to drains designed in accordance with the requirements of Section 5.10.

5.5.5 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.

5.6 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.

5.7 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.

5.8 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.

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

5.9.1 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.

5.9.2 Exfiltration. For a building, the ventilation system(s) shall be designed to ensure that the minimum outdoor air intake exceeds the maximum exhaust airflow whenever 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.

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

5.10.1 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.

5.10.2 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.

5.10.3 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.

5.10.4 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 oz per ft² (1.5 mL per m²) of face area per hour under peak sensible and peak dew point design conditions, considering both latent load and coil face velocity.

5.11 Finned-Tube Coils and Heat Exchangers

5.11.1 Drain Pans. A drain pan in accordance with Section 5.10 shall be provided beneath all dehumidifying cooling coil assemblies and all condensate-producing heat exchangers.

5.11.2 Finned-Tube Coil Selection for Cleaning. Individual finned-tube coils or multiple finned-tube coils in series without 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 dry coil pressure drop at 500 fpm (2.54 m/s) face velocity.

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

5.12 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.

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

5.12.2 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 shall be permitted to be located within the absorption distance recommended by the manufacturer, provided a drain pan complying with the requirements of Section 5.10 is used to capture and remove any water that may drop out of the airstream due to impingement on these obstructions.

5.13 Access for Inspection, Cleaning, and Maintenance

5.13.1 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).

5.13.2 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 exam-

ple, air-handling units, fan-coil units, water-source heat pumps, other terminal units, controllers, and sensors.

5.13.3 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

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

5.14.1 Building Envelope. The building envelope, including roofs, walls, fenestration systems, and foundations, shall comply with the following:

- a. A weather barrier or other means shall be provided to prevent liquid water penetration into the envelope.

Exception: When the envelope is engineered to allow incidental water penetration to occur without resulting in damage to the envelope construction.

- b. An appropriately placed vapor retarder or other means shall be provided to limit water vapor diffusion to prevent condensation on cold surfaces within the envelope.

Exception: When the envelope is engineered to manage incidental condensation without resulting in damage to the envelope construction.

- c. Exterior joints, seams, or penetrations in the building envelope that are pathways for air leakage shall be caulked, gasketed, weather-stripped, provided with continuous air barrier, or otherwise sealed to limit infiltration through the envelope to reduce uncontrolled entry of outdoor air moisture and pollutants.

Note: In localities where soils contain high concentrations of radon or other soil gas contaminants, the authority having jurisdiction may impose additional measures, such as sub-slab depressurization.

5.14.2 Condensation on Interior Surfaces. Pipes, ducts, and other surfaces within the building whose surface temperatures are expected to fall below the surrounding dew-point temperature shall be insulated. The insulation system thermal resistance and material characteristics shall be sufficient to

prevent condensation from forming on the exposed surface and within the insulating material.

Exceptions:

- Where condensate will wet only surfaces that can be managed to prevent or control mold growth.
- Where local practice has demonstrated that condensation does not result in mold growth.

5.15 Buildings with Attached Parking Garages. In order to limit the entry of vehicular exhaust into occupiable spaces, buildings with attached parking garages shall be designed to:

- maintain the garage pressure at or below the pressure of the adjacent occupiable spaces, or
- use a vestibule to provide an airlock between the garage and the adjacent occupiable spaces, or
- otherwise limit migration of air from the attached parking garage into the adjacent occupiable spaces of the building in a manner acceptable to the authority having jurisdiction.

5.16 Air Classification and Recirculation. Air shall be classified, and its recirculation shall be limited in accordance with the following sections.

5.16.1 Classification. Air (return, transfer, or exhaust air) leaving each space or location shall be designated at an expected air-quality classification not less than that shown in Table 5-2, Table 6-1, or Table 6-4 or as approved by the authority having jurisdiction. Air leaving spaces or locations that are not listed in Table 5-2, Table 6-1, or Table 6-4 shall be designated with the same classification as air from the most similar space or location listed in terms of occupant activities and building construction.

Exception: Air from spaces where ETS is present. (Classification of air from spaces where ETS is present is not addressed. Spaces that are expected to include ETS do not have a classification listed in Table 6-1.)

Note: Classifications in Table 5-2, Table 6-1, and Table 6-4 are based on relative contaminant concentration using the following subjective criteria:

- Class 1: Air with low contaminant concentration, low sensory-irritation intensity, and inoffensive odor.
- Class 2: Air with moderate contaminant concentration, mild sensory-irritation intensity, or mildly offensive odors. Class 2 air also includes air that is not necessarily harmful or objectionable but that is inappropriate for transfer or recirculation to spaces used for different purposes.
- Class 3: Air with significant contaminant concentration, significant sensory-irritation intensity, or offensive odor.
- Class 4: Air with highly objectionable fumes or gases or with potentially dangerous particles, bioaerosols, or gases, at concentrations high enough to be considered harmful.

5.16.2 Redesignation

5.16.2.1 Air Cleaning. If air leaving a space or location passes through an air-cleaning system, redesignation of the

TABLE 5-2 Airstreams

Description	Air Class
Diazo printing equipment discharge	4
Commercial kitchen grease hoods	4
Commercial kitchen hoods other than grease	3
Laboratory hoods	4
Residential kitchen vented hoods	3
Hydraulic elevator machine room	2

cleaned air to a cleaner classification shall be permitted, using the subjective criteria noted above, with the approval of the authority having jurisdiction.

5.16.2.2 Transfer. A mixture of air that has been transferred through or returned from spaces or locations with different air classes shall be redesignated with the highest classification among the air classes mixed.

Note: For example, mixed return air to a common system serving both a Class 1 space and a Class 2 space is designated as Class 2 air.

5.16.2.3 Ancillary Spaces. Redesignation of Class 1 air to Class 2 air shall be permitted for Class 1 “spaces that are ancillary to Class 2 spaces.”

Note: For example, an office within a restaurant may be designated as a space ancillary to a Class 2 space thus enabling the office to receive Class 2 air.

5.16.3 Recirculation Limitations. When the Ventilation Rate Procedure of Section 6 is used to determine ventilation air-flow values, recirculation of air shall be limited in accordance with the requirements of this section.

5.16.3.1 Class 1 Air. Recirculation or transfer of Class 1 air to any space shall be permitted.

5.16.3.2 Class 2 Air

5.16.3.2.1 Recirculation of Class 2 air within the space of origin shall be permitted.

5.16.3.2.2 Recirculation or transfer of Class 2 air to other Class 2 or Class 3 spaces shall be permitted, provided the other spaces are used for the same or similar purpose or task and involve the same or similar pollutant sources as the Class 2 space.

5.16.3.2.3 Transfer of Class 2 air to toilet rooms shall be permitted.

5.16.3.2.4 Recirculation or transfer of Class 2 air to Class 4 spaces shall be permitted.

5.16.3.2.5 Class 2 air shall not be recirculated or transferred to Class 1 spaces.

Exception: When using any energy recovery device, recirculation from leakage, carryover, or transfer from the exhaust side of the energy recovery device is permitted. Recirculated Class 2 air shall not exceed 10% of the outdoor air intake flow.

5.16.3.3 Class 3 Air

5.16.3.3.1 Recirculation of Class 3 air within the space of origin shall be permitted.

5.16.3.3.2 Class 3 air shall not be recirculated or transferred to any other space.

Exception: When using any energy recovery device, recirculation from leakage, carryover, or transfer from the exhaust side of the energy recovery device is permitted. Recirculated Class 3 air shall not exceed 5% of the outdoor air intake flow.

5.16.3.4 Class 4 Air. Class 4 air shall not be recirculated or transferred to any space nor recirculated within the space of origin.

5.16.4 Documentation. Design documentation shall indicate the justification for classification of air from any occupancy category, airstream, or location not listed in Table 5-2, Table 6-1, or Table 6-4.

5.17 Requirements for Buildings Containing ETS Areas and ETS-Free Areas. The requirements of this section must be met when a building contains both ETS areas and ETS-free areas. Such buildings shall be constructed and operated in accordance with Sections 5.17.1 through 5.17.8. This section does not purport to achieve acceptable indoor air quality in ETS areas.

5.17.1 Classification. All spaces shall be classified as either ETS-free areas or ETS areas.

5.17.2 Pressurization. ETS-free areas shall be at a positive pressure with respect to any adjacent or connected ETS areas.

Note: Examples of methods for demonstrating relative pressure include engineering analysis, pressure differential measurement, and airflow measurement.

Exceptions:

- a. Dwelling units, including hotel and motel guestrooms, and adjacent properties under different ownership with separation walls that are structurally independent and that contain no openings. This exception shall apply only when:
 1. the separation walls are constructed as smoke barriers in accordance with the requirements of applicable standards;
 2. the separation walls include an air barrier consisting of a continuous membrane or surface treatment in the separation wall that has documented resistance to air leakage; continuity of the barrier shall be maintained at openings for pipes, ducts, and other conduits and at points where the barrier meets the outside walls and other barriers; and
 3. interior corridors common to ETS and ETS-free areas are mechanically supplied with outdoor air at the rate of 0.1 cfm/ft² (0.5 L/s·m²).
- b. Adjacent spaces otherwise required to be held at negative pressure and posted with signs due to the presence of hazardous or flammable materials or vapors.

5.17.3 Separation. Solid walls, floors, ceilings, and doors equipped with automatic closing mechanisms shall separate ETS areas from ETS-free areas.

Exception: Openings without doors are permitted in the separation where engineered systems are designed to

provide airflow from ETS-free areas into ETS areas, notwithstanding eddies that may occur in the immediate vicinity of the boundary between the ETS and ETS-free areas and reverse flow that may occur due to short-term conditions such as wind gusts.

Note: Examples of methods for demonstrating air motion are engineering analysis and the use of a directional airflow indicator at representative locations in the opening, such as on 1 ft (0.3 m) centers or at locations required for duct traverses in standard testing and balancing procedures, such as those described in ASHRAE Standard 111.¹⁶

5.17.4 Transfer Air. When air is transferred from ETS-free areas to ETS areas, the transfer airflow rate shall be maintained regardless of whether operable doors or windows between ETS-free and ETS areas are opened or closed. Acceptable means of doing so include fixed openings in doors, walls, or floors, transfer grilles, transfer ducts, or unducted air plenums with air pressure differentials in compliance with Section 5.17.2.

5.17.5 Recirculation. Air-handling and natural ventilation systems shall not recirculate or transfer air from an ETS area to an ETS-free area.

5.17.6 Exhaust Systems. Exhaust or relief air from an ETS area shall be discharged such that none of the air is recirculated back into any ETS-free area.

5.17.7 Signage. A sign shall be posted outside each entrance to each ETS area. The sign shall state, as a minimum, "This Area May Contain Environmental Tobacco Smoke" in letters at least 1 in. (25 mm) high or otherwise in compliance with accessibility guidelines.

Note: Based on the definition of ETS area, such a sign may be posted outside a larger ETS area that includes the area where smoking is permitted.

Exception: Instead of the specified sign, equivalent notification means acceptable to the authority having jurisdiction may be used.

5.17.8 Reclassification. An area that was previously an ETS area, but now meets the requirements of an ETS-free area, may be classified as such after intentional or allowed smoke exposure has stopped and odor and irritation from residual ETS contaminants are not apparent.

6. PROCEDURES

6.1 General. The Ventilation Rate Procedure, the IAQ Procedure, and/or the Natural Ventilation Procedure shall be used to meet the requirements of this section. In addition, the requirements for exhaust ventilation in Section 6.5 shall be met regardless of the method used to determine minimum outdoor airflow rates.

Note: Although the intake airflow determined using each of these approaches may differ significantly because of assumptions about the design, any of these approaches is a valid basis for design.

6.1.1 Ventilation Rate Procedure. The prescriptive design procedure presented in Section 6.2, in which outdoor air intake rates are determined based on space type/application, occupancy

level, and floor area, shall be permitted to be used for any zone or system.

Note: The Ventilation Rate Procedure minimum rates are based on contaminant sources and source strengths that are typical for the listed occupancy categories.

6.1.2 IAQ Procedure. This performance-based design procedure (presented in Section 6.3), in which the building outdoor air intake rates and other system design parameters are based on an analysis of contaminant sources, contaminant concentration limits, and level of perceived indoor air acceptability, shall be permitted to be used for any zone or system.

6.1.3 Natural Ventilation Procedure. The prescriptive design procedure presented in Section 6.4, in which outdoor air is provided through openings to the outdoors, shall be permitted to be used for any zone or portion of a zone in conjunction with mechanical ventilation systems as required in Section 6.4.

6.2 Ventilation Rate Procedure. The outdoor air intake flow (V_{oi}) for a ventilation system shall be determined in accordance with Sections 6.2.1 through 6.2.7.

Note: Additional explanation of terms used below is contained in Appendix A, along with a ventilation system schematic (Figure A-1).

6.2.1 Outdoor Air Treatment. If outdoor air is judged to be unacceptable in accordance with Section 4.1, each ventilation system that provides outdoor air through a supply fan shall comply with the following sections.

Exception: Systems supplying air for enclosed parking garages, warehouses, storage rooms, janitor's closets, trash rooms, recycling areas, shipping/receiving/distribution areas.

Note: Occupied spaces ventilated with outdoor air that is judged to be unacceptable are subject to reduced air quality when outdoor air is not cleaned prior to introduction to the occupied spaces.

6.2.1.1 Particulate Matter Smaller than 10 Micrometers (PM₁₀). When the building is located in an area where the national standard or guideline for PM₁₀¹ is exceeded, particle filters or air-cleaning devices shall be provided to clean the outdoor air at any location prior to its introduction to occupied spaces. Particulate matter filters or air cleaners shall have a Minimum Efficiency Reporting Value (MERV) of 6 or higher when rated in accordance with ANSI/ASHRAE Standard 52.2.¹⁵

Note: See Appendix E for resources regarding selected PM₁₀ national standards and guidelines.

6.2.1.2 Particulate Matter smaller than 2.5 micrometers (PM_{2.5}). When the building is located in an area where the national standard or guideline for PM_{2.5}¹ is exceeded, particle filters or air cleaning devices shall be provided to clean the outdoor air at any location prior to its introduction to occupied spaces. Particulate matter filters or air cleaners shall have a Minimum Efficiency Reporting Value (MERV) of 11 or higher when rated in accordance with ASHRAE Standard 52.2.¹⁵

Note: See Appendix E for resources regarding selected PM_{2.5} national standards and guidelines.

6.2.1.3 Ozone. Air-cleaning devices for ozone shall be provided when the most recent three-year average annual fourth-highest daily maximum eight-hour average ozone concentration exceeds 0.107 ppm (209 µg/m³).

Note: See Appendix E for a list of United States locations exceeding the most recent 3-year average annual fourth-highest daily maximum 8-hour average ozone concentration of 0.107 ppm.

Such air-cleaning devices shall have a minimum volumetric ozone removal efficiency of 40% when installed, operated, and maintained in accordance with manufacturer recommendations and shall be approved by the authority having jurisdiction. Such devices shall be operated whenever outdoor ozone levels are expected to exceed 0.107 ppm (209 µg/m³).

Exceptions: Air cleaning for ozone is not required when:

- The minimum system design outdoor air intake flow results in 1.5 ach or less.
- Controls are provided that sense outdoor ozone level and reduce intake airflow to result in 1.5 ach or less while complying with the outdoor airflow requirements of Section 6.
- Outdoor air is brought into the building and heated by direct-fired, makeup air units.

6.2.1.4 Other Outdoor Contaminants. When the building is located in an area where the national standard for one or more contaminants not specifically addressed in Section 6.2.1 is exceeded, any design assumptions and/or calculations related to the impact on indoor air quality shall be included in the design documents.

6.2.2 Zone Calculations. *Ventilation zone* parameters shall be determined in accordance with Sections 6.2.2.1 through 6.2.2.3 for each *ventilation zone* served by the ventilation system.

6.2.2.1 Breathing Zone Outdoor Airflow. The outdoor airflow required in the breathing zone of the occupiable space or spaces in a *ventilation zone*, i.e., the breathing zone outdoor airflow (V_{bz}), shall be no less than the value determined in accordance with Equation 6-1.

$$V_{bz} = R_p \cdot P_z + R_a \cdot A_z \quad (6-1)$$

where

A_z = zone floor area: the net occupiable floor area of the *ventilation zone* ft² (m²)

P_z = zone population: the number of people in the *ventilation zone* during typical usage.

R_p = outdoor airflow rate required per person as determined from Table 6-1

Note: These values are based on adapted occupants.

R_a = outdoor airflow rate required per unit area as determined from Table 6-1

Note: Equation 6-1 accounts for people-related sources and area-related sources independently in the determination of the outdoor air rate required at the *breathing zone*. The use of Equation 6-1 in the context of this standard does not necessarily imply that simple addition of outdoor airflow rates for

TABLE 6-1 MINIMUM VENTILATION RATES IN BREATHING ZONE
(This table is not valid in isolation; it must be used in conjunction with the accompanying notes.)

Occupancy Category	People Outdoor Air Rate		Area Outdoor Air Rate		Notes	Default Values			Air Class
	R_p		R_a			Occupant Density (see Note 4)	Combined Outdoor Air Rate (see Note 5)		
	cfm/person	L/s-person	cfm/ft ²	L/s-m ²		#/1000 ft ² or #/100 m ²	cfm/person	L/s-person	
Correctional Facilities									
Cell	5	2.5	0.12	0.6		25	10	4.9	2
Dayroom	5	2.5	0.06	0.3		30	7	3.5	1
Guard stations	5	2.5	0.06	0.3		15	9	4.5	1
Booking/waiting	7.5	3.8	0.06	0.3		50	9	4.4	2
Educational Facilities									
Daycare (through age 4)	10	5	0.18	0.9		25	17	8.6	2
Daycare sickroom	10	5	0.18	0.9		25	17	8.6	3
Classrooms (ages 5–8)	10	5	0.12	0.6		25	15	7.4	1
Classrooms (age 9 plus)	10	5	0.12	0.6		35	13	6.7	1
Lecture classroom	7.5	3.8	0.06	0.3		65	8	4.3	1
Lecture hall (fixed seats)	7.5	3.8	0.06	0.3		150	8	4.0	1
Art classroom	10	5	0.18	0.9		20	19	9.5	2
Science laboratories	10	5	0.18	0.9		25	17	8.6	2
University/college laboratories	10	5	0.18	0.9		25	17	8.6	2
Wood/metal shop	10	5	0.18	0.9		20	19	9.5	2
Computer lab	10	5	0.12	0.6		25	15	7.4	1
Media center	10	5	0.12	0.6	A	25	15	7.4	1
Music/theater/dance	10	5	0.06	0.3		35	12	5.9	1
Multi-use assembly	7.5	3.8	0.06	0.3		100	8	4.1	1
Food and Beverage Service									
Restaurant dining rooms	7.5	3.8	0.18	0.9		70	10	5.1	2
Cafeteria/fast-food dining	7.5	3.8	0.18	0.9		100	9	4.7	2
Bars, cocktail lounges	7.5	3.8	0.18	0.9		100	9	4.7	2
Kitchen (cooking)	7.5	3.8	0.12	0.6		20	14	7.0	2
General									
Break rooms	5	2.5	0.06	0.3		25	7	3.5	1
Coffee stations	5	2.5	0.06	0.3		20	8	4	1
Conference/meeting	5	2.5	0.06	0.3		50	6	3.1	1
Corridors	–	–	0.06	0.3		–			1
Occupiable storage rooms for liquids or gels	5	2.5	0.12	0.6	B	2	65	32.5	2
Hotels, Motels, Resorts, Dormitories									
Bedroom/living room	5	2.5	0.06	0.3		10	11	5.5	1
Barracks sleeping areas	5	2.5	0.06	0.3		20	8	4.0	1
Laundry rooms, central	5	2.5	0.12	0.6		10	17	8.5	2
Laundry rooms within dwelling units	5	2.5	0.12	0.6		10	17	8.5	1
Lobbies/prefunction	7.5	3.8	0.06	0.3		30	10	4.8	1
Multipurpose assembly	5	2.5	0.06	0.3		120	6	2.8	1