

CHAPTER 4

VENTILATION AIR SUPPLY

401.0 General.

This chapter contains requirements for ventilation air supply and exhaust, evaporative cooling systems and makeup-air requirements for direct-gas-fired heaters, industrial air heaters, and miscellaneous heaters.

[OSHPD 1, 2, 3 & 4] See Sections 404.0 through 418.0.

[SFM] Air filters shall comply with all requirements of Part 12, Title 24, Chapter 12-71, SFM Standard 12-71-1.

402.0 Ventilation Air. [Not permitted for OSHPD 1, 2, 3 & 4]

402.1 General Requirements. [Not permitted for OSHPD 1, 2, 3 & 4] All rooms and occupied spaces listed in Table 4-1 shall be designed to have ventilation (outdoor) air for occupants in accordance with this chapter. *Ventilation air supply requirements for occupancies regulated by the California Energy Commission are found in the California Energy Code.*

402.1.1 Construction Documents. The outdoor air ventilation rate and air distribution assumptions made in the design of the ventilation system shall be clearly identified on the construction documents.

402.2 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. [ASHRAE 62.1:5.1]

Exception: An engineered natural ventilation system when approved by the Authority Having Jurisdiction need not meet the requirements of 402.2.1 and 402.2.2. [ASHRAE 62.1:5.1]

402.2.1 Location and Size of Openings.

Naturally ventilated spaces shall be permanently open to and within twenty-five (25) feet (8 m) of operable wall or roof openings to the outdoors, the openable area of which is a minimum of 4 percent of the net occupiable floor area. Where the 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 percent of the area of the interior room nor less than 25 ft² (2.3 m²). [ASHRAE 62.1:5.1.1]

402.2.2 Control and Accessibility. The means to open required operable openings shall be readily accessible to building occupants whenever the space is occupied. [ASHRAE 62.1:5.1.2]

402.3 Mechanical Ventilation. Where natural ventilation is not permitted by this section or the Building Code, mechanical ventilation systems shall be designed, constructed, and installed to provide a method of supply air and exhaust air. The system shall operate so that all rooms and spaces are continuously provided with the required ventilation rate while occupied.

403.0 Ventilation Rates. The design outdoor air intake flow rate for a ventilation system shall be determined in accordance with Sections 403.1 through 403.6.

403.1 Zone Calculations. Zone parameters shall be determined in accordance with Sections 403.1.1 through 403.1.3. [ASHRAE 62.1:6.2.2]

403.1.1 Breathing Zone Outdoor Airflow. The design outdoor airflow required in the breathing zone of the occupiable space or spaces in a zone, i.e., the *breathing zone outdoor airflow* (V_{bz}), shall be determined in accordance with Equation 4-1. [ASHRAE 62.1:6.2.2.1]

$$V_{bz} = R_p P_z + R_a A_z \quad (\text{Equation 4-1})$$

Where:

A_z = zone floor area: the net occupiable floor area of the zone ft.² (m²).

P_z = zone population: The largest number of people expected to occupy the zone during typical usage. If the number of people expected to occupy the zone fluctuates, P_z shall be permitted to be estimated based on averaging approaches described in Section 403.4. If P_z cannot be accurately predicted during design, it shall be estimated based on the zone floor area and the default occupant density listed in Table 4-1.

R_p = outdoor airflow rate required per person as determined from Table 4-1.

R_a = outdoor airflow rate required per unit area as determined from Table 4-1. [ASHRAE 62.1:6.2.2.1]

403.1.2 Zone Air Distribution Effectiveness.

The *zone air distribution effectiveness* (E_z) shall be determined using Table 4-2. [ASHRAE 62.1:6.2.2.2]

403.1.3 Zone Outdoor Airflow. The design *zone outdoor airflow* (V_{oz}), i.e., the outdoor airflow that

must be provided to the zone by the supply air distribution system, shall be determined in accordance with Equation 4-2. [ASHRAE 62.1:6.2.2.3]

$$V_{oz} = V_{bz}/E_z \quad (\text{Equation 4-2})$$

403.2 Single-Zone Systems. When one air handler supplies a mixture of outdoor air and recirculated air to only one zone, the *outdoor air intake flow* (V_{ot}) shall be determined in accordance with Equation 4-3. [ASHRAE 62.1:6.3]

$$V_{ot} = V_{oz} \quad (\text{Equation 4-3})$$

403.3 100% Outdoor Air Systems. When one air handler supplies only outdoor air to one or more zones, the *outdoor air intake flow* (V_{ot}) shall be determined in accordance with Equation 4-4. [ASHRAE 62.1:6.2.4]

$$V_{ot} = \text{all zones } V_{oz} \quad (\text{Equation 4-4})$$

403.4 Multiple-Zone Recirculating Systems. When one air handler supplies a mixture of outdoor air and recirculated return air to more than one zone, the *outdoor air intake flow* (V_{ot}) shall be determined in accordance with Sections 403.4.1 through 403.4.4. [ASHRAE 62.1:6.2.5]

403.4.1 Primary Outdoor Air Fraction. When Table 4-3 is used to determine system ventilation efficiency, the *zone primary outdoor air fraction* (Z_p) shall be determined in accordance with Equation 4-5. [ASHRAE 62.1:6.2.5.1]

$$Z_p = V_{oz}/V_{pz} \quad (\text{Equation 4-5})$$

V_{pz} is the primary airflow to the zone from the air handler, including outdoor air and recirculated return air. [ASHRAE 62.1:6.2.5.1]

403.4.2 System Ventilation Efficiency. The *system ventilation efficiency* (E_v) shall be determined using Table 4-3 or Appendix A of ASHRAE 62.1. [ASHRAE 62.1:6.2.5.2]

403.4.3 Uncorrected Outdoor Air Intake. The design *uncorrected outdoor air intake* (V_{ou}) shall be determined in accordance with Equation 4-6. [ASHRAE 62.1:6.2.5.3]

$$V_{ou} = D \text{ all zones } R_p P_z + \text{all zones } R_a A_z \quad (\text{Equation 4-6})$$

The *occupant diversity*, D , shall be permitted to be used to account for variations in occupancy within the zones served by the system. [ASHRAE 62.1:6.2.5.3]

The *occupancy diversity* is defined as:

$$D = P_s / \text{all zones } P_z \quad (\text{Equation 4-7})$$

where the *system population* (P_s) is the total population in the area served by the system. Alternative methods shall be permitted to be used to account for population diversity when calculating V_{ou} , provided that the resulting value is no less than that determined by Equation 4-6. [ASHRAE 62.1:6.2.5.3]

403.4.4 Outdoor Air Intake. The design *outdoor air intake flow* (V_{ot}) shall be determined in accordance with Equation 4-8. [ASHRAE 62.1:6.2.5.4]

$$V_{ot} = V_{ou}/E_v \quad (\text{Equation 4-8})$$

403.5 Design for Varying Operating Conditions.

403.5.1 Variable Load Conditions. Ventilation systems shall be designed to be capable of providing the required ventilation rates in the breathing zone whenever the zones served by the system are occupied, including all full and part-load conditions. [ASHRAE 62.1:6.2.6.1]

403.5.2 Short-Term Conditions. If it is known that peak occupancy will be of short duration or the ventilation rate will be varied or interrupted for a short period of time, the design shall be permitted to be based on the average conditions over a time period T determined by Equation 4-9. [ASHRAE 62: Section 6.2.6.2]:

$$T = 3 v / V_{bz} \text{ (4-9) IP} \quad (\text{Equation 4-9})$$

where:

T = averaging time period, (min)

v = the volume of the zone for which averaging is being applied, ft^3 (m^3).

V_{bz} = the *breathing zone outdoor airflow* calculated using Equation 4-1 and the design value of the *zone population* P_z , cfm (L/s).

403.6 Dynamic Reset. The system shall be permitted to be designed to vary the design *outdoor air intake flow* (V_{ot}), or the space or zone airflow as operating conditions change.

403.7 Exhaust Ventilation. Exhaust airflow shall be provided in accordance with the requirements in Table 4-4. Exhaust makeup air shall be permitted to be any combination of outdoor air, recirculated air, and transfer air.

404.0 Makeup Air.

Makeup-air requirements for direct gas-fired heaters, industrial air heaters, and miscellaneous heaters are found in Chapters 5 and 9.

405.0 Evaporative Cooling Systems.

Evaporative cooling systems shall comply with this chapter.

Evaporative cooling systems shall be provided with outside air as specified for cooling systems in this code.

Air ducts and fire dampers that are a portion of an evaporative cooling system shall comply with this code.

405.1 Location.

Evaporative cooling systems shall be installed so as to minimize the probability of damage from an external source.

405.2 Access, Inspection, and Repair. Evaporative coolers shall be accessible for inspection, service, and replacement without removing permanent construction.

405.3 Installation.

An evaporative cooler supported by the building structure shall be installed on a substantial level base and shall be secured directly or indirectly to the building structure by suitable means to prevent displacement of the cooler.

Modifications made to the supporting framework of buildings as a result of the installation shall be in accordance with the requirements of the Building Code. Openings in exterior walls shall be flashed in an approved manner in accordance with the requirements of the Building Code.

An evaporative cooler supported directly by the ground shall be isolated from the ground by a level concrete slab extending not less than three (3) inches (76 mm) above the adjoining ground level.

An evaporative cooler supported on an aboveground platform shall be elevated at least six (6) inches (152 mm) above adjoining ground level.

Example: Determine the outdoor air rate required for a single zone AC unit serving an interior 2,000 ft.² meeting/conference room with a design occupancy of 100 people. The system supplies and returns air from the ceiling.

Per Table 4-2, the zone air distribution effectiveness is 1.0 since the system supplies cooling only from the ceiling. Using the rates from Table 4-1 for a meeting/conference room, the minimum system outdoor air rate is calculated to be:

$$\begin{aligned} \text{Vot} &= \frac{R_p P_z + R_a A_z}{E_z} \\ &= \frac{5 \times 100 + 0.06 \times 2,000}{1.0} \\ &= 620 \text{ cfm} \end{aligned}$$

405.4 Evaporative Cooling System for Health Care Facilities [For OSHPD 1, 2, 3 & 4] Direct evaporative cooling systems where the air directly contacts

the wetted surface or spray shall be limited in health facilities to nonpatient areas such as laundry rooms, food preparation areas and boiler or machinery rooms. Similar rooms with high heating-producing equipment will be considered when specifically approved by the enforcing agency. The evaporative pads, shall be a synthetic type. Filters shall be required in accordance with Tables 4-B and 4-C except utility rooms i.e.: boiler or machinery rooms.

406.0 Reserved.

Part I – Ventilation for Health Care Facilities [For OSHPD 1, 2, 3 & 4]

407.0 Ventilation System Details [For OSHPD 1, 2, 3 & 4]

407.1 General.

407.1.1 All supply-air, return air, and exhaust-air systems shall be mechanically operated and such systems for areas listed in Table 4-A shall be operated continuously. Natural ventilation through windows or other openings such as louvers will be considered as supplemental to the required mechanical ventilation systems.

Exception 1. Natural ventilation shall not be used in airborne infection isolation rooms and protective environment rooms.

Exception 2. The number of air changes may be reduced to 25 percent of the indicated value in Table 4-A, when the room is unoccupied, if provisions are made to ensure the following: (1) the number of air changes per hour indicated is reestablished whenever the space is occupied and (2) the pressure relationship with the surrounding rooms is maintained when the air changes per hour are reduced. In areas requiring no continuous directional control as identified in accordance with Table 4-A, ventilation systems may be shut down when the space is unoccupied and ventilation is not otherwise required. Ventilation shall not be reduced in rooms specifically used for airborne infection control, such as waiting rooms, triage rooms, corridors, reception areas, areas adjacent to waiting areas, airborne infection isolation rooms, negative pressure exam room, negative pressure x-ray treatment rooms, and protective environment rooms. All operating and delivery rooms shall maintain a minimum of six air changes per hour of total air when not in use.

407.1.2 Fans serving exhaust systems shall be located at the discharge end of the system. The ventilation rates shown in Table 4-A shall be considered as minimum acceptable rates and shall not be construed as precluding the use of higher ventilation rates if they are required to meet design conditions.

407.1.3 Services/Systems and Utilities. See Section 313.2.

407.2 Outdoor Air Intakes and Exhaust Outlets.

407.2.1 Outdoor Air Intakes. Outdoor air intakes shall be located at least 25 feet (7.62 m) from exhaust outlets of ventilating systems, combustion equipment stacks, medical-surgical vacuum systems, cooling towers and areas that may collect vehicular exhaust or other noxious fumes. The bottom of outdoor air intakes shall be located as high as practicable, but not less than 10 feet (3048 mm), above ground level. If installed through the roof, they shall be located 18 inches (457 mm) above roof level or 3 feet (914 mm) above a flat roof where heavy snowfall is anticipated.

Exceptions:

1. These dimensions may be reduced if it is demonstrated by the submission of details and calculations that location of intakes with respect to exhausts and their orientation, or the use of special filters, provides equal performance.
2. The requirements regarding the bottom of outdoor air intakes and installation through the roof do not apply to skilled nursing facilities, intermediate-care facilities or nonsensitive areas in correctional treatment centers.

407.2.2 Exhaust Outlets. Exhaust outlets shall be located a minimum of 10 feet (3048 mm) above adjoining grade and 10 feet (3048 mm) from doors, occupied areas and operable windows.

Exception: Airborne infection isolation rooms shall comply with Section 414.1.

407.2.3 Relief Air Discharge. Building relief air discharge shall discharge at least 10 feet (3048 mm) from any outside air intake.

407.3 Air Balance.

407.3.1 The ventilation systems shall be designed and balanced to provide the general air balance relationship to adjacent areas, shown in Table 4-A. The ventilation systems shall be balanced in accordance with the latest edition of standards published by the Associated Air Balanced Council (AABC) or the National Environmental Balancing Bureau (NEBB).

407.3.2 Where the variation in static pressure drop across filters is a significant portion of the total pressure drop, static pressure or pressure differential controls or constant volume devices may be required to ensure the maintenance of air balance relationships shown in Table 4-A regardless of filter loading.

Exception: This section does not pertain to skilled nursing facilities, intermediate-care facilities and nonsensitive areas in correctional treatment centers, except for airborne infection isolation rooms and

protective environment rooms.

407.4 Air Circulation.

407.4.1 Air shall be introduced at the cleanest areas and removed at the dirtiest areas in order to reduce chances of airborne cross infection as follows:

407.4.1.1 Air supplied to operating rooms, cesarean operating rooms, cardiac catheterization labs, cystoscopy rooms, delivery rooms and nurseries, shall be delivered at or near the ceiling of the area served, and all air removed from the area shall be removed near floor level. At least two exhaust or recirculation air inlets shall be used in all operating and delivery rooms and shall be located not less than 3 inches (76 mm) nor more than 8 inches (203 mm) above the finished floor.

Exception: For airborne infection isolation rooms and protective environment rooms, see Section 414.0 and 415.0.

407.4.1.2 Room supply air outlets and room recirculation and exhaust air inlets installed in nonsensitive areas shall be located not less than 3 inches (76 mm) above the floor.

Exception: For airborne infection isolation rooms and protective environment rooms, see Section 414.0 and 415.0.

407.4.1.3 Corridors shall not be used to convey supply, return or exhaust air to or from any room if the corridor is required to be of fire resistive construction per the California Building Code.

Exception 1: Mechanically exhausted toilet rooms of 50 square feet (4.7 m²) or less and small rooms of 30 square feet (2.79 m²) or less such as janitor closets, housekeeping rooms, and electrical or telephone closets opening directly onto corridor.

Exception 2: Air transfer caused by pressure differentials in rooms required to have a positive or negative air balance by Table 4-A.

407.4.1.4 No space above a ceiling may be utilized as an outside-air, supply-air, exhaust-air or return-air plenum.

Exception: Designs specifically approved by the enforcing agency.

407.4.1.5 Air from a patient room, exam room, treatment room shall not be transferred to another similar room without first having passed through air filters as required by Table 4-B or Table 4-C.

407.4.1.6 Supply outlets and return and exhaust air inlets shall be located to prevent short-circuiting.

407.5 Variable Air Volume.

407.5.1 Variable Air Volume Systems (VAV).

Variable air volume systems subjecting the patient to

a fluctuating air movement are not acceptable for airborne infection isolation rooms, protective environment rooms or those critically sensitive areas listed in Table 315. For nonsensitive areas, variable air volume systems meeting the following criteria can be considered:

407.5.1.1 The VAV system shall comply with code requirements for outside air, total air, and pressure relationship through the full range of operation from minimum to maximum.

407.5.1.2 The central return or exhaust fan shall be controlled to accomplish the variable air volume requirements of the individual rooms served by the fan as described in Section 407.5.1.3.

407.5.1.3 Variable air volume for return or exhaust air shall be accomplished by utilizing an automatic modulating damper in the return or exhaust air for each zone. The damper will modulate from full open to minimum position in conjunction with the supply air VAV terminal box.

408.0 Filters [For OSHPD 1, 2, 3 & 4]

408.1 General. Filter efficiencies shall be certified by the manufacturer and shall be based on ASHRAE Standard 52.1-1992, Gravimetric and Dust-spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter or ASHRAE Standard 52.2-1999, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size when specifically set forth in these standards.

408.1.1 A filter gauge shall be installed across each filter bank serving central air systems. The gauge shall be red lined or a filter alarm light installed to signal when the recommended maximum static pressure drop has been reached.

408.1.2 Central air-handling systems are defined as any unit requiring duct work on the supply or inlet side that serve more than one room.

408.1.3 Filter banks shall be visually inspected for torn media and bypass in filter frames by means of a flashlight or equivalent, both with fans in operation and stopped. Tears in media and bypass in filter frames shall be eliminated in accordance with the manufacturer's directions and the requirements of the enforcing agency prior to commencing operation of the system.

408.1.4 Central air-handling systems shall be maintained in a reasonably clean condition during construction and shall be cleaned as necessary prior to replacement of temporary filter used during construction to ensure that clean air will be delivered to the occupied spaces.

408.1.5 Filter bank No. 1 shall be located upstream of the air-conditioning equipment. Filter bank No. 2 and filter bank No. 3 shall be located downstream of the supply fan and all cooling and humidification

equipment with efficiencies as indicated in Table 4-B or Table 4-C.

Exception: Dry steam-type humidifiers for local room humidity control may be installed in the supply air duct downstream of the final filter bank where designs are specifically approved by the enforcing agency.

408.1.6 Filter bank No. 2 and filter bank No. 3 media shall be rigid or supported (noncollapsing type) and shall operate on the principles of impingement, straining and diffusion.

408.2 Filters for Hospitals.

408.2.1 All air-ventilation systems shall comply with code requirements of this section and shall have filter bank efficiencies as listed in Table 4-B.

408.2.2 Noncentral recirculating air systems providing cooling to high heat producing equipment located in nonsensitive areas shall have a filter with 30 percent average efficiency based on ASHRAE Standard 52.1-1992 or a minimum efficiency reporting value (MERV) of 8 based on ASHRAE Standard 52.2-1999.

408.2.3 Noncentral air systems serving any areas not listed in Table 4-B shall be provided with filter arrangement and efficiency specifically approved by the enforcing agency.

408.2.4 Noncentral recirculating air handling systems, i.e., through-the-wall units, fan coil units, and heat pumps may be utilized for single patient rooms of one or more beds. Filtration for these units shall have a minimum weight arrestance value of 50 percent, based on ASHRAE Standard 52.1-1992 or a minimum efficiency reporting value (MERV) of 1, based on ASHRAE Standard 52.2-1999. The air ventilation system providing the minimum air changes of outdoor air shall comply with Table 4-B. These units may be used as recirculating units only. All outdoor air requirements shall be met by a separate central air handling systems.

408.3 Filters for Skilled Nursing Facilities, Intermediate Care Facilities and Correctional Treatment Centers.

408.3.1 The air ventilation systems shall comply with code requirements of this section for skilled nursing facilities, intermediate care facilities and correctional treatment centers and shall have filter bank efficiencies as listed in Table 4-C.

408.3.2 Noncentral air systems serving single patient rooms of one or more beds shall comply with Table 4-C.

408.3.3 Noncentral recirculating air-handling systems, i.e. through the wall units, may be utilized for each patient room with one or more beds. Filtration for these units shall have a minimum weight arrestance value of 50 percent, based on ASHRAE Standard 52.1-1992 or a minimum efficiency reporting value (MERV) of 1, based on

ASHRAE Standard 52.2-1999. The air ventilation system providing the minimum air changes of outdoor air shall comply with Table 4-C. These units may be used as recirculating units only. All outdoor air requirements shall be met by a separate central air handling system.

408.3.4 Airborne infection isolation rooms, protective environment rooms and sensitive areas in correctional treatment centers shall comply with Section 408.2.

408.4 Filters for Outpatient Facilities.

408.4.1 The air ventilation systems shall comply with code requirements of this section for outpatient facilities and shall have filter bank efficiencies as listed in Table 4-B.

408.4.2 Noncentral air systems serving individual rooms shall comply with Table 4-B.

409.0 Ducts [FOR OSHPD 1, 2, 3 & 4]

409.1 Ducts which penetrate construction, intended for X-ray or other radiation protection, shall not impair the effectiveness of the protection.

409.2 Duct linings and their use shall meet the requirements of Chapter 6, California Mechanical Code.

409.3 Cold-air ducts shall be insulated wherever necessary or to prevent condensation problems.

409.4 The anchorage and supporting structural elements for airducts shall be designed to withstand the lateral forces as required by the California Building Code, Title 24, Part 2.

410.0 Laboratories [For OSHPD 1, 2, 3 & 4]

410.1 The minimum amount of outdoor air in laboratories shall be provided in accordance with Table 4-A. A filter with 90 percent average efficiency based on ASHRAE Standard 52.1-1992 or a minimum efficiency reporting value (MERV) of 14, based on ASHRAE Standard 52.2-1999 shall be installed in the air-supply system at its entrance to the media transfer room.

410.2 Laboratory hoods for general use shall have a minimum average face velocity of 75 feet per minute (380 m/s). Hoods in which infectious or highly radioactive materials are processed shall have a face velocity of 100 feet per minute (510 m/s). Bacteriological safety cabinets used for processing infectious materials shall have an average face velocity of 50 to 70 feet per minute (255 m/s to 355 m/s) and shall be equipped with a means for disinfection.

410.3 Laboratory hoods shall not be connected to the general building exhaust system. Hoods in which infectious, incompatible or highly radioactive materials are processed each shall have an independent exhaust system with the fan installed at the discharge point of the system. Duct systems serving laboratory hoods shall be constructed of stainless steel of a type which will resist corrosion by materials normally handled. Duct systems serving laboratory hoods used for purposes other than

those needed for routine diagnostic laboratory procedures and in which highly radioactive materials or a significant volume of highly oxidizing agents are used shall be constructed of USS 18-8 stainless steel or the equivalent for a minimum distance of 10 feet (3048 mm) from the hood. Such ducts shall be equipped with wash down facilities and shall be consistent with fire safety requirements. Fire dampers and smoke dampers shall not be installed in laboratory hood exhaust systems.

410.4 The exhaust from all laboratory hoods in which infectious or radioactive materials are processed shall be equipped with filters having a 99 percent efficiency based on the DOP (dioctylphthalate) test method or a minimum efficiency reporting value (MERV) of 15, based on ASHRAE Standard 52.2-1999. Filter frames shall be durable and carefully dimensioned, and shall provide an airtight fit with the enclosing duct work. All joints between filter segments and the enclosing duct work shall be gasketed or sealed to provide a positive seal against air leakage.

411.0 Kitchen and Dining Areas [For OSHPD 1, 2, 3 & 4]

411.1 The air from dining areas may be used to ventilate the food preparation areas only after it has passed through a filter with at least an 80 percent average efficiency based on ASHRAE Standard 52.1-1992 or a minimum efficiency reporting value (MERV) of 13, based on ASHRAE Standard 52.2-1999.

Exception: For skilled nursing facilities, intermediate care facilities and correctional treatment centers, the air from dining area may be used to ventilate food preparation areas only after it has passed through a filter with a 50 percent average efficiency based on ASHRAE Standard 52.1-1992 or a minimum efficiency reporting value (MERV) of 10, based on ASHRAE Standard 52.2-1999.

412.0 Boiler, Mechanical and Electrical Rooms [For OSHPD 1, 2, 3 & 4]

412.1 Boiler, heater and electrical equipment rooms shall be provided with outdoor air so as to maintain combustion rates of equipment and temperatures in the rooms and in adjoining areas as rated in this chapter.

412.2 Floor surfaces in occupied spaces above such rooms should not exceed a temperature of 85°F (29.4°C), and suitable insulation may be required.

413.0 Odorous Rooms [For OSHPD 1, 2, 3 & 4]

413.1 Rooms in areas where excessive heat or moisture is generated, where objectional odors or dust are present, or where flammable or toxic gases may accumulate, which are used by health facility personnel or patients, shall be provided with exhaust ventilation to change the air a minimum of ten times per hour.

413.2 Kitchen, morgues and laundries located inside a hospital building or skilled nursing facility in which patients are accommodated, or treated, shall be ventilated

with exhaust systems which will provide a minimum of ten air changes per hour and prevent odors from entering patient areas.

414.0 Airborne Infection Isolations Rooms [For OSHPD 1, 2, 3 & 4]

414.1 Exhaust Systems. A separate, dedicated exhaust system shall be provided for airborne infection isolation rooms. The dedicated system may serve more than one airborne infection isolation room, adjoining toilet room and anteroom. The exhaust ducts shall be identified by appropriate labeling with the words "Caution Airborne Infection Isolation Rooms Exhaust" or similar terminology. Such labeling shall be in a manner which is not readily removable and shall appear on the exhaust duct at intervals of not more than 20 feet (6096 mm) and at least once near each room and each story traversed by the exhaust system. Exhaust fans shall comply with Section 407.1.2. The discharge from exhaust fans shall be located above the roof and shall be located a minimum of 25 feet (7620 mm) from areas that may be occupied, doors, operable windows, outdoor air intakes, or other openings into the building. The exhaust fan discharge shall be labeled in a manner which readily identifies the precautions which should be observed. To ensure that the airborne contaminants do not reenter the building, one of the following shall be provided:

414.1.1 Exhaust discharge from fan shall extend at least 7 feet (2134 mm) above the roof and discharge vertically upward. Self-draining stacks or equivalent shall be used for rain protection. Rain caps which divert the exhaust toward the roof shall be prohibited; or

414.1.2 Exhaust shall discharge above roof level and through an accessible HEPA filter. The HEPA filter shall be located upstream of the exhaust fan and have a minimum efficiency of 99.97 percent based on the DOP method in accordance with Mil-Std. 282 or a minimum efficiency reporting value (MERV) of 17, based on ASHRAE Standard 52.2 1999. Filter gage shall be installed across the filter. For maintenance of air balance relationship, see Section 407.3.2. The 25-foot (7620 mm) dimension required by Section 414.1 may be reduced when a 99.97 percent HEPA filter or a minimum efficiency reporting value (MERV) of 17, based on ASHRAE Standard 52.2 1999 is used and the reduced dimension is specifically approved by the enforcing agency.

414.2 Air Distribution. The supply outlets and exhaust inlets shall be located to provide airflow patterns that prevent stagnation of the air and eliminate short circuiting of the supply to the exhaust, and minimize exposure of health care workers to airborne infectious particles. Supply-air outlets shall be located at or near the ceiling and at the end of the airborne infection isolation room which is opposite the head of the bed. Exhaust

registers shall be located on the wall behind the patient's head, or as close to that wall as practical and shall be located not less than 3 inches (76 mm) nor more than 24 inches (610 mm) above the finished floor.

Exception: For correctional treatment centers, the location and design of the supply outlets an exhaust or return inlets shall not compromise the safety, security and protection of staff, inmates and property.

415.0 Protective Environment Rooms [For OSHPD 1, 2, 3 & 4]

415.1 Air Distribution. The supply outlets and exhaust and return inlets shall be located to provide airflow patterns that prevent stagnation of the air and eliminate short circuiting of the supply to the exhaust or return. Supply air shall be delivered at or near the ceiling and near the patient's bed. All exhaust or return registers shall be located near the entrance to the protective environment room and not less than 3 inches (76 mm) nor more than 8 inches (203 mm) above the finished floor.

Exception: For correctional treatment centers, the location and design of the supply outlets and exhaust or return inlets shall not compromise the safety, security and protection of staff, inmates and property.

416.0 Alarms – Airborne Infection Isolation Rooms and Protective Environment Rooms [OSHPD 1, 2, 3 & 4]

416.1 An alarm system which is based on static pressure control, volumetric control, or directional flow measurement shall be provided for each isolation room. The alarm system shall consist of a display monitor located on the corridor wall near the door to the room and a visual and audible alarm which annunciates at the room and at a nurses' station or other suitable location that will provide responsible surveillance. A time delay shall be provided to allow for routine openings of doors. The alarm shall annunciate when the supply, return, or exhaust fans are interrupted and when one of the following conditions is not being met during closed door conditions:

1. When the minimum air quantity difference of 75 cfm (35.4 L/s) required by Table 4-A is not being maintained; or
2. When a minimum pressure differential of 0.001 inch (0.003 kPa) of water and a minimum inward (outward for protective environment rooms) air velocity of 100 feet per minute (0.508 m/s) is not being maintained at the air transfer opening required by Table 4-A.

416.2 Other acceptable alarm systems will be allowed when designs are specifically approved by the enforcing agency.

416.3 [For OSHPD 4] For correctional treatment centers, the alarm system shall not create false alarms or security hazards.

416.4 Prior to acceptance of the rooms, the alarm system shall be tested and operated to demonstrate to the owner or designated representative that the installation and performance of the system conforms to design intent.

417.0 Testing Airborne Infection Isolation Rooms and Protective Environment Room [For OSHPD 1, 2, 3 & 4] Prior to acceptance of the rooms, all mechanical systems shall be tested, balanced and operated to demonstrate to the owner or designated representative that the installation and performance of the systems conform to design intent. All testing and balancing shall be performed by a qualified independent agency certified by the Associated Air Balance Council (AABC) or the National Environmental Balancing Bureau (NEBB). Test results shall be documented for maintenance files.

418.0 Design Requirements for Ethylene Oxide (ETO) Sterilization Areas [For OSHPD 1, 2, 3 & 4]

418.1 Air Changes. The ETO sterilization equipment room shall be provided with minimum air changes per hour per Table 4-A and be maintained at a negative air balance.

418.2 Exhaust Requirements.

418.2.1 All air from the ETO sterilizer equipment room shall be exhausted to the outside by a dedicated system or other approved method.

418.2.2 The exhaust fan for the dedicated system shall be located at the discharge point of the system and identified as ETO Equipment Room Exhaust.

418.2.3 Discharge Point. The discharge point shall be a minimum of 25 feet (7620 mm) away from any outside intake, operable window or personnel passage.

418.3 Ventilation Requirements.

418.3.1 Aeration units. The aeration units shall be ventilated through a nonrecirculating dedicated ventilation exhaust system.

418.3.2 Capture box. When the drain is not located in the ETO sterilizer equipment room, ventilation is required by a capture box.

418.3.3 Cylinder change. When not located in the ETO sterilizer equipment room, exhaust during cylinder change is required by installing a hood that is part of a dedicated ventilation exhaust system, positioned no more than 1 foot (305 mm) above or behind the point where the change of cylinders takes place.

418.3.4 Sterilizer relief valve. The ventilation of sterilizer relief valve is required through a pipe connected to the outlet of the relief valve exhausted directly to the outdoors at a point high enough to be away from passers-by, and not near any windows that open, nor near any air-conditioning or ventilation air intakes.

418.3.5 Ventilation of sterilizer door area. The system shall be designed to capture the ETO when the door is opened following the completion of the sterilization process. A hood or canopy closed on each

end should be installed over the sterilization door. A hood or canopy shall be connected to a dedicated exhaust ventilation system.

418.4 Gas Valves. Installation of gas line hand valves at the connection to the supply cylinders are required to minimize leakage during cylinder change.

418.5 Alarm Systems. An Audible and visual alarm system shall be installed to alert sterilizer operating personnel if the air flow falls below design cubic feet per minute (L/S).

**TABLE 4-A – PRESSURE RELATIONSHIP AND VENTILATION REQUIREMENTS FOR
GENERAL ACUTE CARE HOSPITALS, SKILLED NURSING FACILITIES,
INTERMEDIATE CARE FACILITIES, CORRECTIONAL**

TREATMENT CENTERS, OUTPATIENTS FACILITIES AND LICENSED CLINICS					
A	B	C	D E		F
Area Designation	AIRBALANCE RELATIONSHIP TO ADJACENT AREAS ⁸	MINIMUM AIR CHANGES IF 100% O.S.A.	CONDITIONED AIR NOT 100% O.S.A		ALL AIR D DIRECTLY TO OUTDOORS
			Minimum Air Changes of Outdoor Air per hour	EXHAUSTE Minimum Total Air Changes per hour	
<i>Operating room, cardiac cath lab and cystoscopy</i>	<i>P⁷</i>	<i>12</i>	<i>5</i>	<i>20</i>	
<i>Patient holding preparation¹</i>	<i>E</i>	<i>6</i>	<i>2</i>	<i>6</i>	
<i>Delivery room, cesarean operating room</i>	<i>P</i>	<i>12</i>	<i>5</i>	<i>20</i>	
<i>Newborn/well baby nursery</i>	<i>P</i>	<i>6</i>	<i>2</i>	<i>6</i>	
<i>Post anesthesia care unit</i>	<i>E</i>	<i>6</i>	<i>2</i>	<i>6</i>	Yes
<i>Intensive care service spaces, Acute respiratory – care service spaces, Burn service spaces, Coronary – care service Spaces, Pediatric intensive – care service spaces⁹</i>	<i>P</i>	<i>6</i>	<i>2</i>	<i>6</i>	
<i>Newborn intensive care</i>	<i>P</i>	<i>6</i>	<i>2</i>	<i>6</i>	
<i>Emergency department:¹</i>					
<i>Waiting area</i>	<i>N</i>	<i>12</i>	<i>2</i>	<i>12</i>	Yes ²
<i>Operating room</i>	<i>P</i>	<i>12</i>	<i>5</i>	<i>20</i>	
<i>Treatment room</i>	<i>E</i>	<i>6</i>	<i>2</i>	<i>6</i>	
<i>Trauma room³</i>	<i>P</i>	<i>12</i>	<i>5</i>	<i>20</i>	
<i>Triage</i>	<i>N</i>	<i>12</i>	<i>2</i>	<i>12</i>	Yes
<i>Patient room</i>	<i>E</i>	<i>2</i>	<i>2</i>	<i>6</i>	
<i>Patient area corridor</i>	<i>E</i>	<i>2</i>	<i>2</i>	<i>4</i>	
<i>Labor/delivery/recovery room, Labor/ delivery/recovery/postpartum room</i>	<i>E</i>	<i>2</i>	<i>2</i>	<i>6</i>	
<i>Airborne infection isolation room</i>	<i>N⁴</i>	<i>12</i>	<i>2</i>	<i>12</i>	Yes
<i>Airbone infection isolation anteroom</i>	<i>P⁴</i>	<i>10</i>	<i>2</i>	<i>10</i>	Yes
<i>Protective environment room</i>	<i>P⁵</i>	<i>15</i>	<i>2</i>	<i>15</i>	
<i>Protective environment anteroom</i>	<i>N⁶</i>	<i>15</i>	<i>2</i>	<i>15</i>	
<i>Treatment, and examination rooms</i>	<i>E</i>	<i>6</i>	<i>2</i>	<i>6</i>	
<i>Bronchoscopy and endoscopy</i>	<i>N</i>	<i>12</i>	<i>2</i>	<i>12</i>	Yes
<i>Special purpose room (SNF & ICF only)</i>	<i>E</i>	<i>6</i>	<i>2</i>	<i>6</i>	Yes

A	B	C	D	E	F
Area Designation	AIRBALANCE RELATIONSHIP TO ADJACENT AREAS ^a	MINIMUM AIR CHANGES IF 100% O.S.A.	CONDITIONED AIR NOT 100% O.S.A		ALL AIR EXHAUSTE D DIRECTLY TO OUTDOORS
			Minimum Air Changes of Outdoor Air per hour	Minimum Total Air Changes per hour	
Radiological/Imaging:					
Angiography Room	P	12	5	15	
X-ray (diagnostic and treatment)	E	6	2	6	
CT Scan	E	6	2	6	
MRI room	E	6	2	6	
Fluoroscopy Room	N	6	2	6	Yes
Dark Room	N	12	2	12	Yes
Negative-pressure x-ray room	N	12	2	12	Yes
Ultra sound room	E	6	2	6	
Gamma camera	E	6	2	6	
Waiting area	N	12	2	12	Yes
Bedpan room	N			10	Yes
Bathroom	N			10	Yes
Janitors' closet, Housekeeping room	N			10	Yes
Sterilizer equipment room	N			10	Yes
Sub sterile room	E	10	2	10	Yes
Linen and trash chute rooms	N			10	Yes
Food preparation centers	E	10	2	10	Yes
Dining room	E	10	2	10	
Dishwashing room	N			10	Yes
Dietary day storage	E			2	
Laundry, general (clean and dirty)	E	10	2	10	Yes
Soiled linen sorting and storage	N			10	Yes
Clean linen storage	P	2	2	2	
Anesthesia storage	E	8		8	Yes
Central medical and surgical supply:					
Soiled or decontamination room	N	4	2	4	Yes
Clean workroom	P	4	2	4	
Unsterile supply	E	2	2	2	
Pharmacy/medicine room	P	2	2	4	
Laboratory					
General	N	6	2	6	
Biochemistry	P	6	2	6	
Cytology	N	6	2	6	Yes
Glass washing	N	10	2	10	Yes
Histology	N	6	2	6	Yes
Microbiology	N	6	2	6	Yes
Nuclear medicine	N	6	2	6	Yes
Pathology	N	6	2	6	Yes
Serology	P	6	2	6	
Sterilizing	N	10	2	10	Yes
Media transfer	P	4	2	4	

A	B	C	D	E	F
Area Designation	AIRBALANCE RELATIONSHIP TO ADJACENT AREAS ⁶	MINIMUM AIR CHANGES IF 100% O.S.A.	CONDITIONED AIR NOT 100% O.S.A		ALL AIR EXHAUSTE D DIRECTLY TO OUTDOORS
			Minimum Air Changes of Outdoor Air per hour	Minimum Total Air Changes per hour	
Infectious disease and virus	N	6	2	6	Yes
Bacteriology	N	6	2	6	Yes
Negative-pressure treatment/exam room	N	12	2	12	Yes
Physical therapy and hydrotherapy	N	6	2	6	
Soiled workroom (utility room)	N	4	2	10	Yes
Clean workroom	P	4	2	6	
Autopsy	N	12	2	12	Yes
Toilet room	N			10	Yes
Shower room	N			10	Yes
Waiting area primary care clinic	N	10	2	10	Yes ^e

P = Positive E = Equal N = Negative

- The pressure relationship of the entire emergency department shall be negative to other adjacent areas.
- Air may be recirculated if a high-efficiency particulate air (HEPA) filter with a minimum efficiency of 99.97 percent or a minimum efficiency reporting value (MERV) of 17 is installed in the return air duct which serves the waiting area.
- The term "trauma room" as used here is the operating room space in the emergency department or other trauma reception area that is used for emergency surgery. The first aid room and/pr "emergency room" used for initial treatment of accident victims may be ventilated as noted for the "treatment rooms."
- The anteroom shall have positive air pressure in relation to the airborne infection isolation room. A door louver, transfer grille, or other acceptable means shall be provided to allow for airflow from the anteroom to the airborne infection isolation room. The airborne infection isolation room shall have negative pressure in relation to the anteroom, and the adjoining toilet room shall have negative pressure in relation to the airborne infection isolation room. Negative pressure shall be achieved by balancing the exhaust cfm to no less than 75 cfm (35.4 L/s) greater than the supply cfm for each airborne infection isolation room the anteroom serves. The overall area consisting of the anteroom, airborne infection isolation room, and adjoining toilet room shall have an equal air balance in relation to the corridor.
Exception: For correctional treatment centers, the location and design of the air transfer device shall not compromise the safety, security and protection of staff, inmates, and property.
- Positive-pressure shall be achieved by balancing the supply cfm to not less than 75 cfm (35.4 L/s) greater than the exhaust and return cfm for each protective environment room the anteroom serves.
- The anteroom shall have negative air pressure in relation to the protective environment room. A door louver, transfer grille, or other acceptable means shall be provided to allow for airflow from the protective environment room to the anteroom. The protective environment room shall have positive-pressure in relation to the anteroom and adjoining toilet room. Positive pressure shall be achieved by balancing the supply cfm to not less than 75 cfm (35.4 L/s) greater than the exhaust and return cfm. The overall area consisting of the anteroom, protective environment room, and adjoining toilet room shall have an equal air balance in relation to the corridor.
Exception: For correctional treatment centers, the location and design of the air transfer device shall not compromise the safety, security, and protection of staff, inmates, and property.
- Cystoscopy may have equal air balance relationship to adjacent areas when approved by Authority Having Jurisdiction.
- For operating rooms, cardiac catheterization labs, angiography rooms, cystoscopy rooms, delivery rooms, cesarean operating rooms, newborn intensive care, intensive care units, and nurseries provide approximately 15% excess supply air to the room or a sufficient quantity of excess supply air to maintain an appropriate positive air balance based on the room tightness and number of doors. For all rooms not listed in this footnote or not listed in Table 315 requiring either a positive or negative air balance, provide approximately 10% differential cfm between supply and return/exhaust airflow but not less than 25 cfm differential shall be provided regardless of room size. Room function, size, and tightness may be considered when determining the differential airflow required.
- Intensive care patient rooms, which contain a modular toilet/ sink combination unit within the room, shall be provided with a minimum of 75 cfm of exhaust directly over the modular toilet/sink combination unit.

**TABLE 4-B – Filter Efficiencies for Central Ventilation and Air-Conditioning Systems
in General Acute Care Hospitals, Acute Psychiatric Hospitals, Outpatient Facilities and Licensed Clinics.¹**

Area Designation	Minimum Number of Filter Banks	Filter Efficiency % Filter Bank (Minimum efficiency reporting value MERV) ⁵		
		No. 1 ¹	No. 2 ¹	No. 3 ¹
Orthopedic operating room, bone marrow transplant operating room, organ transplant operating room	3	30%	90%	99.97% ³
		(8)	(14)	(17)
Protective environment rooms	3	30%	90%	99.97% ⁴
		(8)	(14)	(17)
Angiography; cardiac cath labs; operating rooms; delivery rooms nurseries; patient care, treatment, cystoscopy, cesarean operating room, diagnostic and related areas; airborne infection isolation rooms; areas providing direct patient service or clean supplies such as sterile and clean processes	2	30%	90%	
		(8)	(14)	
Laboratories	2	30%	80%	
		(8)	(13)	
Administrative, med staff support areas, bulk storage, soiled holding areas, food preparation areas and laundries	1	30%		
		(8)		

1 Based on ASHRAE Standard 52.1-1992 or ASHRAE Standard 52.2-1999.

2 Based on DOP test in accordance with MIL-STD-282 or based on ASHRAE Standard 52.2-1999.

3 HEPA filters at air outlet or other locations when approved by the Authority Having Jurisdiction.

4 HEPA filter located in the supply duct which serves the positive-pressure isolation room or rooms may serve more than one supply outlet and more than one positive-pressure isolation room. HEPA filter or a filter with minimum efficiency reporting value (MERV) of 17 installation shall be designed and equipped to permit safe removal, disposal and replacement of filters.

5 The numbers in parentheses represent MERV rating based on ASHRAE Standard 52.2-1999.

**TABLE 4-C – Filter Efficiencies for Central Ventilation and Air-Conditioning Systems
in Skilled Nursing Facilities and Intermediate Care Facilities and Correctional Treatment Centers.¹**

Area Designation	Minimum Number of Filter Banks	Filter Efficiency % Filter Bank	
		(Minimum efficiency reporting value MERV) ⁵	
		No. 1 ¹	No. 2 ¹
All areas for inpatient care, treatment and/or diagnosis, and those areas providing direct service or cleaning supplies	2	30%	80%
		(8)	(13)
Administrative, bulk storage, soiled holding, laundries and food prep areas	1	30% ² (8)	

1 Based on ASHRAE Standard 52.1-1992 or ASHRAE Standard 52.2-1999.

2 Filters are not required for evaporative coolers serving laundries and food preparation areas.

3 The numbers in parentheses represent MERV rating based on ASHRAE 52.2-1999.

TABLE 4-1 MINIMUM VENTILATION RATES IN BREATHING ZONE 2,3

[ASHRAE 62.1:Table 6-1]

Note: Ventilation air supply requirements for occupancies regulated by the California Energy Commission are found in the California Energy Code.

Occupancy Category ⁶	People Outdoor Air Rate R_p (cfm/person)	Area Outdoor Air Rate R_A (cfm/ft ²)	Default Occupant Density ⁴ (people/1,000 ft ²)
Correctional Facilities			
Cell	5	0.12	25
Day room	5	0.06	30
Guard stations	5	0.06	15
Booking/waiting	7.5	0.06	50
Educational Facilities			
Day care (through age 4)	10	0.18	25
Classrooms (ages 5-8)	10	0.12	25
Classrooms (age 9 plus)	10	0.12	35
Lecture classroom	7.5	0.06	65
Lecture hall (fixed seats)	7.5	0.06	150
Art classroom	10	0.18	20
Science laboratories ^E	10	0.18	25
Wood/metal shop	10	0.18	20
Computer lab	10	0.12	25
Media center ^A	10	0.12	25
Music/theater/dance	10	0.06	35
Multi-use assembly	7.5	0.06	100
University/College Laboratories			
Food and Beverage Service			
Restaurant dining rooms	7.5	0.18	70
Cafeteria/fast food dining	7.5	0.18	100
Bars, cocktail lounges	7.5	0.18	100
General			
Conference/meeting	5	0.06	50
Corridors	-	0.06	-
Storage rooms ^B	-	0.12	-
Hotels, Motels, Resorts, Dormitories			
Bedroom/living room	5	0.06	10
Barracks sleeping areas	5	0.06	20
Lobbies/pre-function	7.5	0.06	30
Multipurpose assembly	5	0.06	120
Office Buildings			
Office space	5	0.06	5
Reception areas	5	0.06	30
Telephone/data entry	5	0.06	60
Main entry lobbies	5	0.06	10
Miscellaneous spaces			
Bank vaults/safe deposit	5	0.06	5
Computer (not printing)	5	0.06	4
Pharmacy (prep. area)	5	0.18	10
Photo studios	5	0.12	10
Shipping/receiving ^B	-	0.12	-

TABLE 4-1 MINIMUM VENTILATION RATES IN BREATHING ZONE ^{2,3} (continued)
[ASHRAE 62.1:Table 6-1]

Transportation waiting	7.5	0.06	100
Warehouses ^B	-	0.06	-
Public Assembly Spaces			
Auditorium seating area	5	0.06	150
Places of religious worship	5	0.06	120
Courtrooms	5	0.06	70
Legislative chambers	5	0.06	50
Libraries	5	0.12	10
Lobbies	5	0.06	150
Museums (children's)	7.5	0.12	40
Museums/galleries	7.5	0.06	40
Retail			
Sales (except as below)	7.5	0.12	15
Mall common areas	7.5	0.06	40
Barber shop	7.5	0.06	25
Beauty and nail salons	20	0.12	25
Pet shops (animal areas)	7.5	0.18	10
Supermarket	7.5	0.06	8
Coin-operated laundries	7.5	0.06	20
Sports and Entertainment			
Sports arena (play area)	-	0.30	-
Gym, stadium (play area)	-	0.30	30
Spectator areas	7.5	0.06	150
Swimming (pool & deck) ^C	-	0.48	-
Disco/dance floors	20	0.06	100
Health club/aerobics room	20	0.06	40
Health club/weight rooms	20	0.06	10
Bowling alley (seating)	10	0.12	40
Gambling casinos	7.5	0.18	120
Game arcades	7.5	0.18	20
Stages, studios ^D	10	0.06	70

GENERAL NOTES FOR TABLE 4.1

- 2 Smoking:** This table applies to no-smoking areas. Rates for smoking-permitted spaces must be determined using other methods.
- 3 Air Density:** Volumetric airflow rates are based on an air density of 1.2 kgda/m³ (0.075 lbda/ft³), which corresponds to dry air at a barometric pressure of 101.3 kPa (1 atm) and an air temperature of 21 °C (70 °F). Rates shall be permitted to be adjusted for actual density but such adjustment is not required for compliance with this chapter.
- 4 Default Occupant Density:** The default occupant density shall be used when actual occupant density is not known.
- 6 Unlisted Occupancies:** If the occupancy category for a proposed space or zone is not listed, the requirements for the listed occupancy category that is most similar in terms of occupant density, activities, and building construction shall be used.

ITEM-SPECIFIC NOTES FOR TABLE 4.1

- A** For high school and college libraries, use values shown for Public Spaces – Library.
- B** Rate may not be sufficient when stored materials include those having potentially harmful emissions.
- C** Rate does not allow for humidity control. Additional ventilation or dehumidification may be required to remove moisture.
- D** Rate does not include special exhaust for stage effects, e.g., dry ice vapors, smoke.
- E** No class of air has been established for this occupancy category.

TABLE 4-2
Zone Air Distribution Effectiveness
[ASHRAE 62.1:Table 6-2]

Air Distribution Configuration	E_z
Ceiling supply of cool air	1.0
Ceiling supply of warm air and floor return	1.0
Ceiling supply of warm air at least 15°F (8°C) above space temperature and ceiling return.	0.8
Ceiling supply of warm air less than 15°F (8°C) above space temperature and ceiling return provided that the 150 fpm (0.8 m/s) supply air jet reaches to within 4.5 ft. (1.4 m) of floor level.	1.0
Floor supply of cool air and ceiling return provided that the 150 fpm (0.8 m/s) supply jet reaches at least 4.5 ft. (1.4 m) above the floor.	1.0
Floor supply of cool air and ceiling return, provided low velocity displacement ventilation achieves unidirectional flow and thermal stratification.	1.2
Floor supply of warm air and floor return	1.0
Floor supply of warm air and ceiling return	0.7
Makeup supply drawn in on the opposite side of the room from the exhaust or return.	0.8
Makeup supply drawn in near to the exhaust or return location	0.5

Notes for Table 4-2

1. "Cool air" is air cooler than space temperature.
2. "Warm air" is air warmer than space temperature.
3. "Ceiling" includes any point above the breathing zone.
4. "Floor" includes any point below the breathing zone.
5. As an alternative to using the above values, determine E_z in accordance with ASHRAE Standard 129 for all air distribution configurations except unidirectional flow.

TABLE 4-3
System Ventilation Efficiency
[ASHRAE 62.1:Table 6-3]

Max (Z_p)	E_v
< 0.15	1.0
< 0.25	0.9
< 0.35	0.8
< 0.45	0.7
< 0.55	0.6
> 0.55	Use ASHRAE 62.1, Appendix A

Notes for Table 4-3.

1. "Max Z_p " refers to the largest value of Z_p , calculated using Equation 4-5, among all the zones served by the system.
2. Interpolating between table values is permitted.

TABLE 4-4 Minimum Exhaust Rates
[ASHRAE 62.1:Table 6-4]

Occupancy Category	Exhaust Rate cfm/unit	Exhaust Rate cfm/ft ²	Exhaust Rate L/s-unit	Exhaust Rate L/s-m ²
Art classrooms	-	0.70	-	3.5
Auto repair rooms ¹	-	1.50	-	7.5
Barber shop	-	0.50	-	2.5
Beauty and nail salons	-	0.60	-	3.0
Cell with toilet	-	1.00	-	5.0
Darkrooms	-	1.00	-	5.0
Arena ²	-	0.50	-	2.5
Kitchen – commercial	-	0.70	-	3.5
Kitchenettes	-	0.30	-	1.5
Locker rooms	-	0.50	-	2.5
Locker/dressing rooms	-	0.25	-	1.25
Parking garages ³	-	0.75	-	3.7
Janitor, trash, recycle	-	1.00	-	5.0
Pet shops (animal areas)	-	0.90	-	4.5
Copy, printing rooms	-	0.50	-	2.5
Science lab classrooms	-	1.00	-	5.0
Toilets – public ⁴	50/70	-	25/35	-
Toilet – private ⁵	25/50	-	12.5/25	-
Woodwork shop/classroom	-	0.50	-	2.5

Notes For Table 4-4

- 1 Stands where engines are run shall have exhaust systems that directly connect to the engine exhaust and prevent escape of fumes.
- 2 The rates do not include exhaust from vehicles or equipment with internal combustion engines.
- 3 Exhaust not required if two or more sides comprise walls that are at least 50% open to the outside.
- 4 Rate is per water closet or urinal. Provide the higher rate where periods of heavy use are expected to occur, e.g., toilets in theatres, schools, and sports facilities.
- 5 Rate is for a toilet room intended to be occupied by one person at a time. For continuous system operation during normal hours of use, the lower rate may be used. Otherwise use the higher rate.