CHAPTER XV
VENTILATION AND AIR FOR COMBUSTION

1500—VENTILATION (For Commercial Areas)

A minimum requirement of one air change per hour is to be used to overcome infiltration by producing a slight positive pressure within the area. The ASHRAE "Guide" recommends that a minimum ventilation of 5 cfm per person be used, but 7½ cfm per person is preferred. Although these standards seem adequate, where unusual odors pose a problem, or more fresh air is needed, local ventilation ordinances may require greater quantities of outdoor air. 6-11-74

For face velocities of hoods, and range exhaust velocities, it is recommended that suggested velocities in the ASHRAE "Guide" be used. In some areas noise may be a factor. On a stage the maximum air velocity should not be more than 25 fpm. In radio and television studios the noise levels must be kept very very low, in the range of NC-20 to 25, otherwise sensitive microphones will pick up air movement noises.

Ventilation requirements vary widely with local regulations, and with varying conditions in different geographical areas of the State. Good design practice should be followed for the minimum air change or cfm purpose. It may be to reduce odors, fumes, stale or contaminated air, or to maintain a proper balance of the metabolic gases.

The following table from the "Guide" Chapter 65, (1967) is used by permission, for possible solutions to ventilation problems.

VENTILATION DESIGN CRITERIA

Functional Area	Air Changes per Hour	Cfm/ Person	Functional Area	Air Changes per Hour	Cfm/ Person
Anesthesia, hospital	8-12	—	Kitchens	10-30	—
Animal room	12-16	—	Laundries	10-60	—
Auditorium	10-20	10	Libraries	15-25	10
Autopsy, hospital	8-12	10	Locker room	2-15	—
Bakery	20-60	—	Machine shop	8-12	—
Bowling alley	15-30	30	Mechanical equipment	8-12	—
Churches	15-25	5	Media room, hospital	6-10	—
Cystoscopy, hospital	8-10	20	Nursery	10-15	—
Classroom	10-30	40	Offices	6-20	10
Conference	25-35	—	Operating room, hospital	10-15	—
Corridors	3-10	—	Ozalid room	8-12	—
Delivery room, hospital	8-12	—	Paint finishing	18-22	—
Dairies	5-15	—	Radiology	6-10	—
Dishwashing	30-60	—	Restaurant (dining room)	6-20	10
Drycleaning	20-40	—	Retail stores	18-22	10
Foundries	5-20	—	Residences	5-20	—
Gymnasiums	—	1½ sq ft	Telephone equipment	6-10	—
Garages	6-30	—	Traffic and flight cont.	18-22	10
Hydrotherapy, hospital	6-10	—	Toilets	8-20	—
Isolation ward	6-10	—	Transmitter, receiver and electronic	10° rise	—
Janitor and cleaning	8-12	—	Welding	18-22	—

NOTE—Individual design conditions may cause variation in these values of considerable magnitude.
Refer to Section 805, "Mechanical Ventilation" pg. 8-5, Chapter VIII N. C. Building Code, Vol. I.

1501—VENTILATION—Bathrooms, Toilets, and rest rooms.

All bathrooms in residential construction shall be provided with means of exhausting air to the outside. Ducts shall penetrate the ceiling and roof, or

side wall. Exhausting air into an attic space shall be prohibited.

All public bath, toilet and rest rooms shall be provided with a system of mechanical or gravity ventilation as per N. C. Plumbing Code, Section 423.1, Page 405, 1968 Edition.

1502—VENTILATION—Kitchen (Residential or Commercial)

Kitchen exhaust fans shall be connected with duct work conveying exhaust air to the outside. Kitchen exhaust shall not empty into an attic space. For gage and clearance see Section ~~906 (b)~~ 916(b). For zero clearance use insulating material to withstand 1800 deg. F. For exhaust systems from units of multi-story construction provision shall be made as follows:

(a) Provide negative pressure by using continuously operating fan.

(b) or, extend sub-ducts up 22 inches into vertical riser.

6-11-74 Refer to G-16 of Appendix for illustration. Refer to Figure 4, Page A-138 of Appendix G

1503—NEGATIVE PRESSURE FROM CIRCULATING FAN

The return system and circulating fan shall be arranged so that negative pressure from the circulating fan cannot affect the air supply for combustion or act to draw products of combustion from joints or openings in the furnace or flue.

1504—VENTILATION (Requirements—Shower & Toilet Rooms for Industrial & Commercial)

All ventilation requirements shall comply with the recommendations of the "Guide and Data Book" by ASHRAE. The following table is included for reference.

TABLE 1
VENTILATION
For Locker Rooms, Toilets & Shower Spaces

Locker Rooms	
Coat hanging or clean change room for non-laboring shift employees with clean work clothes	1 cfm per sq. ft.
Change room for laboring employees with wet or sweaty clothes	2 cfm per sq. ft. 7 exhausted from each locker
Change room for heavy laborers or workers assigned to working and cleaning where clothes will be wet or pick up heavy odors.	3 cfm per sq. ft. 10 exhausted from each locker
Toilet Spaces	2 cfm per sq. ft. at least 25 cfm per toilet facility, 200 cfm min.
Shower Spaces	2 cfm per sq. ft. at least 50 cfm per shower head, 200 cfm min.

1505—VENTILATION (Elevator Equipment Rooms)

Adequate air for ventilation shall be provided, using outside air, without excessive velocities and in keeping with recognized engineering practice.

1506—VENTILATION (Mechanical Equipment Rooms)

Compressor rooms, rooms having air compressors, vacuum pumps, and machinery generating heat shall have provided adequate circulation of ventilating air, with properly sized grilles, louvres, and if an outside wall is

not available either provide ducts of ample size to the outside wall or a method of admitting air from the roof and exhausting it to the outside.

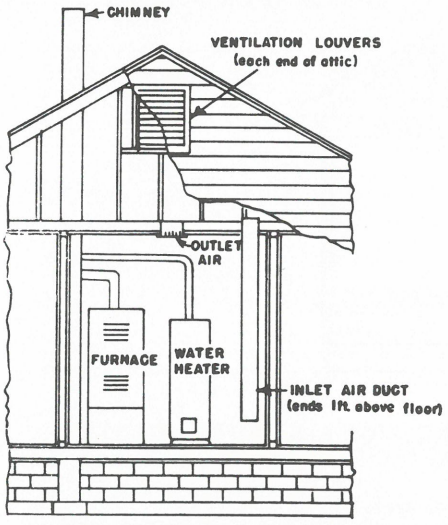
1507—AIR FOR COMBUSTION AND VENTILATION

(a) GENERAL

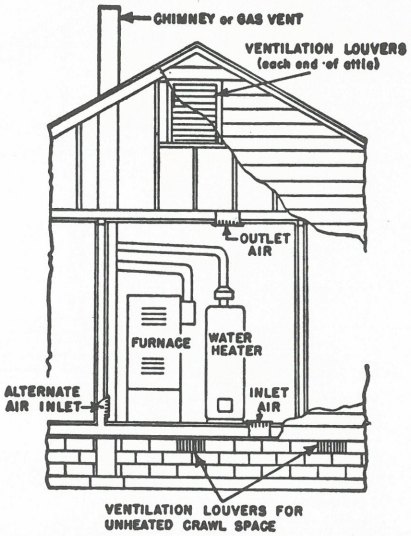
Heating appliances shall be installed in a location in which the facilities for ventilation permit satisfactory combustion of oil, gas or solid fuels; with proper venting and the maintenance of ambient temperature at safe limits under normal conditions of use. Appliances shall be located in such a manner as not to interfere with proper circulation of air within the confined space. Outside air shall be introduced. Ducts used to convey air from the outdoors shall be of the same cross section area as the free area of the openings to which they connect. The minimum dimension of rectangular air ducts shall be not less than 3 inches.

When air is taken from outdoors to a confined space, the space shall be provided with two permanent openings, one beginning within 12 inches of the top or ceiling and one beginning within 12 inches of the bottom or floor of the enclosure. The openings shall communicate directly, or by ducts, with outdoors or spaces (crawl or attic) that freely communicate with outdoors.

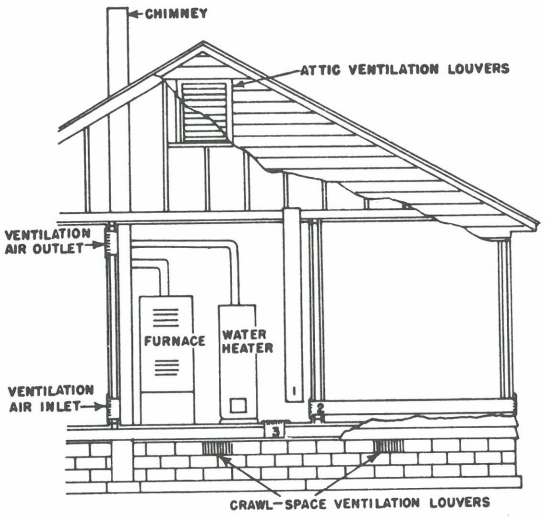
When directly communicating with the outdoors each opening shall have a minimum free area of one square inch per 4,000 btu per hour of total input rating of all appliances in the enclosure irrespective of the fuel used. When communicating with the outdoors through vertical ducts each opening shall have a minimum free area of one square inch per 4,000 btu per hour of total input rating of all appliances in the enclosure, irrespective of the fuel used. When communicating with the outdoors through horizontal ducts each opening shall have a minimum free area of one square inch per 2000 btu per hour of total input rating of all appliances irrespective of the fuel used. See figures below.



(a) Air for combustion from attic with ventilation into attic space.



(b) Combustion air from crawl space with ventilation into attic space.



(c) Appliances Located in Confined Spaces. Ventilation Air from Inside Building—Combustion Air from Outside, Ventilated Attic or Ventilated Crawl Space.

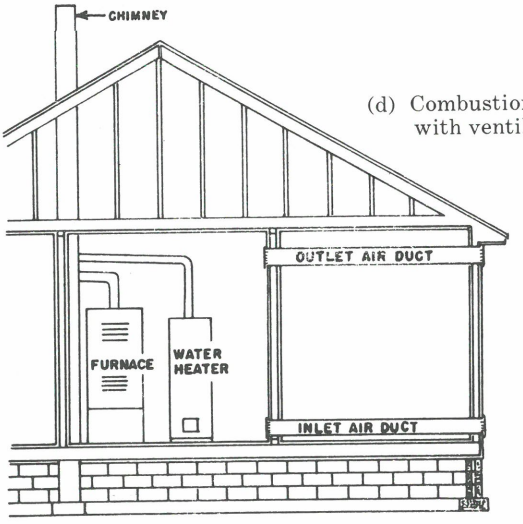
Note: Ducts used for make-up air may be connected to the cold air return of the heating system only if they connect directly to outdoor air.

Attic ventilation louvers are required at each end of attic with alternate air inlet No. 1.

Nos. 1, 2, and 3 mark alternate locations for air from outdoors. Free area shall be not less than 1 square inch per 5,000 Btu per hour of the total input rating of all appliances in the enclosure.

Crawl-space ventilation louvers for unheated crawl space are required with alternate air inlet No. 3.

Each ventilation air opening from inside the building shall have a free area of not less than 1 square inch per 1,000 Btu per hour of the total input rating of all appliances in the enclosure.



(d) Combustion air from outdoors with ventilation to outside.

METHODS OF PROVIDING COMBUSTION AIR AND VENTILATION FOR RESIDENTIAL CONSTRUCTION

(b) LOUVERS AND GRILLES (Free area) AIA
In calculating free area consideration shall be given to the blocking effect of louvers, grilles or screens protecting openings. Screens used

shall not be smaller than ¼ inch mesh. If the free area through a design of louver or grille is known, it shall be used in calculating the size opening required to provide the free area specified. If the design and free area is not known, it shall be assumed that wood louvers will have 20-25 per cent free area and metal louvers and grilles will have 60-75 per cent free area.

(c) SPECIALLY ENGINEERED INSTALLATIONS AIA

The size of combustion air openings specified shall not govern when special engineering assures an adequate supply of air for combustion and ventilation and dilution of flue gases.

(d) In case of induced draft, or forced draft, use criteria from N.C. State Boiler Code.

(e) PROCESS AIR 54A Industrial

In addition to air needed for combustion and ventilation, sufficient process air shall be provided as required for: cooling equipment or material, controlling dew point, heating, drying, oxidation or dilution, safety exhaust, draft hood operation, odor control and compressors.

(f) FRESH AIR INTAKES (Protection) AIA Page 61

(1) Fresh air intakes shall be protected against exterior fire exposure by approved fire doors, dampers or other suitable protection in accordance with the degree of exposure hazard.

(2) Fresh air intakes shall be protected by screens of corrosion resistant material not larger than one-half inch mesh.

(g) AIR INLET AND OUTLET OPENINGS (Location and Protection) AIA Page 61

(1) Discharge and exhaust air openings and recirculating air intakes shall be located at least 3 inches above the floor, except that floor openings may be permitted under seats in places of assembly having fixed seats.

(2) When located less than 7 feet above the floor, inlet and outlet openings shall be protected by a substantial grille or screen that has openings through which a half-inch sphere will not pass.

(h) AIR REQUIREMENTS (General—Gas Equipment) - 54A Industrial

The air requirements of the gas equipment to be installed and the air supply in the building in which the equipment is to be installed shall be checked to determine that sufficient air is available. If normal air infiltration is inadequate, sufficient make-up air shall be supplied to prevent any possibility of creating a partial vacuum in the building.

NOTE: Suitable precautions should be taken to assure that the air supply will be clean. When necessary, make-up air should be heated.

(i) COMBUSTION AIR (Gas Equipment) 54A

Complete combustion of gas requires approximately one cubic foot of air, at standard conditions, for each 100 Btu of fuel burned, but additional air for proper burner operation (atmospheric burner) may be required. When the building space in which gas equipment is installed does not have adequate air infiltration to assure proper combustion, one or more permanent openings to the out-of-doors or to spaces freely communicating with the out-of-doors shall be required. Such openings shall hava a minimum free area of one square inch for every 1,000 Btu per hour for equipment with draft hoods.

(j) VENTILATION AIR (Gas Equipment) 54A

In addition to air needed for combustion, sufficient air shall be sup-

plied for ventilation, including all air required for comfort and proper working conditions for personnel.

(k) VENTING—BASIC RULE—(Gas Equipment) 54A

Adequate provisions shall be made for the safe removal of combustion products, process fumes, and used ventilation air. The venting system shall conform to the following specific requirements and to those of the authority having jurisdiction. Hoods may be used in place of direct flue connections, particularly when the process itself requires fume disposal.

(l) REMOVAL OF PRODUCTS OF COMBUSTION (Gas Equipment) 54A

When located in a large and well ventilated space, temporary industrial *gas equipment* may be operated by discharging the products of combustion directly into the space.

(m) PROTECTION OF GAS EQUIPMENT FROM FUMES OF GASES OTHER THAN PRODUCTS OF COMBUSTION 54A

Where corrosive, or flammable process fumes are present, suitable means for their safe disposal shall be provided. Such fumes include, among others, carbon monoxide, hydrogen sulfide, ammonia, chlorine, halogenated hydrocarbons.

NOTE: Halogenated hydrocarbons are particularly injurious and corrosive after contact with flames or hot surfaces.

(n) AIR FILTERS

Air filters shall be approved types that will not burn freely or emit large volumes of smoke or other objectionable products of combustion when attacked by flames.

Liquid adhesive coatings used on air filters shall have a flash-point not lower than 325 F., Cleveland open cup tester.

6-11-74 moved to Section 614

(o) Filters qualifying as Class 1 and Class 2 shall be accepted as meeting these requirements. An evaporative cooler containing a combustible filter and water evaporation medium, such as excelsior, shall not be used.

NOTE: A Class 1 air filter is one which, when clean, does not contribute fuel when attacked by flame and emits only negligible amounts of smoke when tested by the method of Underwriters' Laboratories, Inc. Standard 900, September 1965.
A Class 2 air filter is one which, when clean, burns moderately when attached by flame or emits moderate amounts of smoke, or both when tested by the method of Underwriters Laboratories, Inc., Standard 900, September 1965.
For Classification of filters by efficiency, and Groups see pages 96-102 Chapter 9, ASHRAE Guide, 1967 Ed.

1508—STAGE AND PROJECTION BOOTH VENTILATION AND PROTECTION (Excerpts from Chapter V, N. C. Building Code, Vol. 1)

(a) VENTILATION OF STAGE

Over the stage shall be provided one or more ventilators of metal of non-combustible material, equipped with movable shutters or sash, having an aggregate clear area of not less than one-eighth the area of the stage, constructed to open automatically and instantly by approved heat-actuated devices. Suitable means for manual operations shall be provided in addition. If glass is used in the construction, only wired glass shall be used in such parts where the breaking of glass would cause it to fall on the stage.

(b) INDOOR MOTION PICTURE PROJECTION BOOTHS (Using Flammable Film)

(1) Every motion picture projector using *flammable films*, together with all electrical devices, rheostats, and other film equipment,

and all films shall be enclosed in a booth constructed as specified in N. C. Building Code, Volume 1.

(2) Ventilation shall be provided by one or more mechanical exhaust systems which shall draw air from each arc lamp housing and from one or more points near the ceiling. Systems shall exhaust to outdoors either directly or through a non-combustible flue used for no other purpose. Exhaust capacity shall be not less than 15 cubic feet nor more than 50 cubic feet per minute for each arc lamp, plus 200 cubic feet per minute for the room itself. For a booth containing two projectors, the exhaust flue shall be not less than 18 inches in diameter or equivalent size. Systems shall be controlled from within the enclosure and have pilot lights to indicate operation. The exhaust system serving the projection room may be extended to cover rooms associated therewith, such as rewind rooms. No dampers shall be installed in such exhaust systems. Ventilation of these rooms shall not be connected in any way with ventilating or air conditioning systems serving other portions of the building.

(3) Exhaust ducts shall be of non-combustible material, and shall either be kept 1 inch from combustible material or covered with ½ inch of approved, non-combustible, heat insulating material.*

(4) Fresh air intakes other than those direct to the open air shall be be protected by approved fire shutters arranged to operate automatially with the port shutters.

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* Refer to Section 901 (d) concerning dampers in exhaust ducts.