

ever is the greater) during occupancy. Likewise, locker rooms, wardrobes, shower rooms and swimming pools should be provided with at least 2 cu ft of air per minute for each square foot of floor area.

The air supply or exhaust for kitchens should be entirely separate from any other supply or exhaust system and should remove at least 2 cu ft for occasionally used kitchens and 4 cu ft for commercial kitchens for each square foot of floor area every minute during occupancy and use. This air removal volume should be not less than a complete air change every ten minutes for occasionally used kitchens and a complete air change every five minutes for commercial kitchens.

In some codes for compulsory ventilation of rooms a credit is allowed for the air which may leak in or out through openings such as operable windows and doors. It is conceivable that if there are many such openings, properly located so as to permit air movement from them across the room, no other ventilation need be supplied. There are, of course, many rooms which have operable closures on these openings but which have all of the openings on but one side, and which therefore are not as effective for ventilating purposes as when they are on opposite sides of the room.

There are openings having closures of such types as to be unsatisfactory for ventilating purposes, particularly windows having center pivots vertically above each other so that sun shades are constantly involved, and through which the rain and snow may enter when opened only a trifle. Openings in skylights are not satisfactory unless they are used in connection with windows and doors and should be given no credit against the air change requirement unless they are in rooms which have accredited side wall openings.

EXHAUST OPENINGS

Outlets from buildings should never *look* out through a vertical wall, because in the winter the wind is likely to stop or reduce greatly the outflow of the much lighter warm rejected air. Outlets from low buildings will reverse and will cause trouble if close to a more lofty building, despite the presence of fans in the circuit, since the wind when blowing against the wall will *mushroom* in all directions and often will create a pressure sufficient to prevent egress of air. The most effective ventilation outlet is an open-top chimney, as many ventilator hoods interpose resistance to air flow roughly proportional to their effectiveness in keeping out rain and snow.

OTHER FACTORS AFFECTING VENTILATION

The location and the type of heat-losing and heat-gaining surfaces in a room affect the ventilation of the room, since heating units cause local up-drafts and open windows and cool walls cause down-drafts. Rooms which have ceiling radiators usually have cool floors, if no mechanical circulation is provided. Mechanical ventilation therefore reduces stratification in such cases.

RECIRCULATION

The saving in operating costs obtainable by recirculation of the air in ventilation systems, while very considerable, must not be obtained at the

expense of air quality. At no time during occupancy should there be taken from out of doors less than 10 cu ft of air per minute for each occupant. The percentage of recirculated air may be varied to suit the seasonal changes so as to conserve heat in winter and refrigeration in summer. Where recirculation is employed the problem is primarily one of air conditioning, because of the necessity for controlling the physical properties and quality of the air.

Toilets and similar rooms and all kitchens in buildings using recirculation should be separately, mechanically ventilated, with the exhaust in excess of the supply, in order to prevent objectionable odors from diffusing into other parts of the building. This air removal may in many cases be sufficient to insure an adequate replacement of outside air to the general recirculating system. For additional information on recirculation, refer to Chapter 28.

DRAFTS

Air velocities that are noticeable may be a very serious menace to health under certain conditions. The air coming in contact with the occupants of a room should not exceed a velocity of 50 fpm as measured with a Kata thermometer.

When using an upward system of air supply, as through floor mushrooms, or an air supply from the side, so as to bring the incoming air directly into contact with the occupant, drafts may result from the introduction of air at temperatures slightly cooler than the average room temperature. For this reason, the downward system of air distribution is more often used in large and densely occupied places of assemblage. (See Chapter 32). The air should be brought in at a point high enough to permit of its being diffused before coming into contact with the occupants. Under such conditions the temperature difference may be considerably greater with a resulting decrease in volume of air handled.

HEAT REQUIRED FOR VENTILATION

The heat required to warm the outside air introduced for ventilation purposes (H_v) must be added to the normal heat losses of the building and may be determined by means of the following basic formula:

$$H_v = 0.24(t - t_o) W_v$$

where

0.24 = specific heat of air at constant pressure.

t = room temperature.

t_o = outside temperature.

W_v = weight of air to be introduced per hour in pounds = $Q_v d$

Q_v = volume of air to be introduced, cubic feet per hour.

d = density of air = 0.075 at 70 F.

Example. A building in which the temperature to be maintained is 70 F, requires 10,000 cfm. If the outside temperature is -10 F, how much heat will be required to warm the air introduced for ventilation purposes to the room temperature?

Solution. $Q_v = 10,000 \times 60 = 600,000$ cfh. $d = 0.075$. $W_v = 0.075 \times 600,000 = 45,000$ lb. $t = 70$ F. $t_o = -10$ F. $H_v = 0.24 \times [70 - (-10)] \times 45,000 = 865,000$ Btu per hour.