

following formulae may be used to determine an equivalent wind velocity to be used in connection with Tables 1 and 2 that will allow for both wind velocity and temperature difference:

$$M_e = \sqrt{M^2 - 1.75 a} \quad (1)$$

$$M_e = \sqrt{M^2 + 1.75 b} \quad (2)$$

where

M_e = equivalent wind velocity to be used in conjunction with Tables 1 and 2.

M = wind velocity upon which infiltration would be determined if temperature difference were disregarded.

a = distance of windows under consideration from mid-height of building if above mid-height.

b = distance if below mid-height.

The coefficient 1.75 allows for about one-half the temperature difference head.

Example 1. If $M = 15$, the equivalent wind velocity at a height of 150 ft from the ground for a building 180 ft high would be

$$M_e = \sqrt{15^2 - 1.75 \times 60} = 11 \text{ mph}$$

For a window on the ground floor:

$$M_e = \sqrt{15^2 + 1.75 \times 90} = 19.6 \text{ mph}$$

For buildings of unusual height, Equation 1 would indicate negative infiltration at the highest stories, which condition may, at times, actually exist, although probably greater wind velocities should be figured at such extremely high levels.

Sealing of Vertical Openings²

In tall, multi-story buildings, every effort should be made to seal off vertical openings such as stair-wells and elevator shafts from the remainder of the building. Stair-wells should be equipped with self-closing doors, and in exceptionally high buildings, should be closed off into sections of not over 10 floors each. Plaster cracks should be filled. Elevator enclosures should be tight and solid doors should be used.

If the sealing of the vertical openings is made effective, no allowance need be made for the chimney effect. Instead the greater wind movement at the high altitudes makes it advisable to install additional heating surface on the upper floors above the level of neighboring buildings, this additional surface being increased as the height is increased. One arbitrary rule is to increase the heating surface on floors above neighboring buildings by an amount ranging from 5 per cent to 20 per cent. This extra heating surface is required only on the windward side and on windy days, and hence automatic temperature control is especially desirable with such installations.

Heating Surface for Stair-Wells²

In stair-wells that are open through many floor levels although closed off from the remainder of each floor by doors and partitions, the strati-

fication of air makes it advisable to increase the amount of heating surface at the lower levels and to decrease the amount at higher levels even to the point of omitting all heating surface on the top several floor levels. One rule is to calculate the heating surface of the entire stair-well in the usual way and to place 50 per cent of this in the bottom third, the normal amount in the middle third and the balance in the top third.

HEAT EQUIVALENT OF AIR ENTERING BY INFILTRATION

The heat required to warm cold, outside air, which enters a room by infiltration, to the temperature of the room is given by the following equation:

$$H_i = 0.24 Q d (t - t_o) \quad (3)$$

where

H_i = Btu per hour required for heating air leaking into building from outside temperature t_o to inside temperature t .

Q = cubic feet of air entering per hour at inside temperature t .

d = density (pounds per cubic foot) of air at inside temperature t .

t = inside temperature at the proper level.

t_o = outside air temperature for which heating system is designed.

0.24 = specific heat of air.

It is sufficiently accurate to take $d = 0.075$ lb, in which case the equation reduces to

$$H_i = 0.018 Q (t - t_o) \quad (4)$$

While a heating reserve must be provided to warm inleaking air on the windward side of a building, this does not necessarily mean that the heating plant must be provided with a reserve capacity, since the inleaking air, warmed at once by adequate heating surface in exposed rooms, will move transversely and upwardly through the building, thus relieving other radiators of a part of their load. The actual loss of heat of a building caused by infiltration is not to be confused with the necessity for providing additional heating capacity for a given space. Infiltration is a disturbing factor in the heating of a building, and its maximum effect (maximum in the sense of an average of wind velocity peaks during the heating season above some reasonably chosen minimum) must be met by a properly distributed reserve of heating capacity, which reserve, however, is not in use at all places at the same time, nor in any one place at all times.

Example 2. A 12 ft by 18 ft room with a ceiling height of 10 ft contains three 2 ft-8 in. by 5 ft-6 in. plain double-hung wood windows with $\frac{1}{16}$ -in. crack and $\frac{3}{64}$ -in. clearance. Assume a wind velocity of 20 mph and a temperature difference of 75 F. Neglecting chimney effect, what is the maximum heat loss due to infiltration?

Solution. From Table 2, the leakage per foot of crack is 59.3 cfh. Length of crack for the three windows is 57 ft. The infiltration (Q) is equal to 59.3×57 or 3380 cfh, and the additional heat loss (maximum) due to infiltration is equal to $0.018 \times 3380 \times 75$ or 4560 Btu per hour. (Since the room has a volume of 2160 cu ft, the air changes would be $\frac{3380}{2160}$ or 1.57 per hour).

²See Flue Action in Tall Buildings, by H. L. Alt (*Heating, Piping and Air Conditioning*, May, 1932).