

duction in infiltration is secured, but the application of the sash does give an air space which reduces the heat transmission and helps prevent the frosting of the windows³. When storm sash are applied to poorly fitted windows, a reduction in leakage of 50 per cent may be secured.

Door Leakage

Doors vary greatly in fit because of their large size and tendency to warp. For a well fitted door, the leakage values for a poorly fitted double-hung wood window may be used. If poorly fitted, twice this figure should be used. If weatherstripped, the values may be reduced one-half. A single door which is frequently opened, such as might be found in a store, should have a value applied which is three times that for a well fitted

TABLE 3. INFILTRATION THROUGH OUTSIDE DOORS FOR COOLING LOADS^a
Expressed in Cubic Feet per Minute per Person Entering Room

APPLICATION	PAIR 36 IN. SWINGING DOORS, SINGLE ENTRANCES ^b
Bank.....	7.5
Barber Shop.....	4.5
Broker's Office.....	7.0
Candy and Soda.....	6.0
Department Store.....	8.0
Dress Shop.....	2.5
Drug Store.....	7.0
Furrier.....	2.5
Hospital Room.....	3.5
Lunch Room.....	5.0
Men's Shop.....	3.5
Office.....	3.0
Office Building.....	2.0
Public Building.....	2.5
Restaurant.....	2.5
Shoe Store.....	3.5

^aFor doors located in only one wall or where doors in other walls are of revolving type.

^bVestibules with double pair swinging doors, infiltration may be assumed 75 per cent of swinging door values.

Infiltration for 72 in. revolving doors may be assumed 60 per cent of swinging door values.

door. This extra allowance is for opening and closing losses and is kept from being greater by the fact that doors are not used as much in the coldest and windiest weather.

The infiltration rate through swinging and revolving doors is generally a matter of judgment by the engineer making cooling load determinations and in the absence of adequate research data the values given in Table 3 represent current engineering practice⁴. These values are based on the average number of persons in a room at a specified time, which may also be the same occupancy assumed for determining the outside ventilation requirements outlined in Chapters 2 and 7.

³Fuel Saving Resulting from the Use of Storm Windows and Doors, by A. P. Kratz and S. Konzo (A.S.H.V.E. TRANSACTIONS, Vol. 42, 1936, p. 87).

⁴The Infiltration Problem of Multiple Entrances, by A. M. Simpson and K. B. Atkinson (A.S.H.V.E. JOURNAL SECTION, Heating, Piping and Air Conditioning, June, 1936, p. 345). Infiltration Characteristics of Entrance Doors, by A. M. Simpson (Refrigerating Engineering, June, 1936).

Air Change Method

The amount of air leakage is sometimes roughly estimated by assuming a certain number of air changes per hour for each room, the number of changes assumed being dependent upon the type, use and location of the room, as indicated in Table 4. This method may be used to advantage as a check on the calculations made in the more exact manner. The air leakage for vestibules due to opening and closing of doors is sometimes based on the air change method, even though the air leakage estimates for other rooms are based on the crack method.

INFILTRATION DUE TO TEMPERATURE DIFFERENCE

The air exchange due to temperature difference, inside to outside, is a chimney effect, causing air to enter through openings at lower levels and

TABLE 4. AIR CHANGES TAKING PLACE UNDER AVERAGE CONDITIONS EXCLUSIVE OF AIR PROVIDED FOR VENTILATION

KIND OF ROOM OR BUILDING	NUMBER OF AIR CHANGES TAKING PLACE PER HOUR
Rooms, 1 side exposed.....	1
Rooms, 2 sides exposed.....	1½
Rooms, 3 sides exposed.....	2
Rooms, 4 sides exposed.....	2
Rooms with no windows or outside doors.....	½ to ¾
Entrance Halls.....	2 to 3
Reception Halls.....	2
Living Rooms.....	1 to 2
Dining Rooms.....	1 to 2
Bath Rooms.....	2
Drug Stores.....	2 to 3
Clothing Stores.....	1
Churches, Factories, Lofts, etc.....	½ to 3

to leave at higher levels⁵. Although it is not appreciable in low buildings, this loss should be considered in tall, single story buildings with openings near the ground level and near the ceiling. Also in tall, multi-story buildings it may be a considerable item unless the sealing between various floors and rooms is quite perfect.

In tall buildings, temperature difference or chimney effect will produce a head that will add to the effect of the wind at lower levels and subtract from it at higher levels. On the other hand, the wind velocity at lower levels may be somewhat abated by surrounding obstructions. Furthermore, the chimney effect is reduced in multi-story buildings by the partial isolation of floors, thereby preventing free upward movement, so that wind and temperature difference may seldom cooperate to the fullest extent. Making the rough assumption that the *neutral zone*⁶ is located at

⁵A.S.H.V.E. RESEARCH REPORTS No. 994—Wind Velocities Near a Building and Their Effect on Heat Loss, by F. C. Houghten, J. L. Blackshaw and Carl Gutberlet (A.S.H.V.E. TRANSACTIONS, Vol. 40, 1934, p. 387). No. 1069—Heating Requirements of an Office Building as Influenced by the Stack Effect, by F. C. Houghten and Carl Gutberlet (A.S.H.V.E. TRANSACTIONS, Vol. 43, 1937, p. 437). Flue Action in High Buildings, by H. L. Alt (A.S.H.V.E. JOURNAL SECTION, Heating, Piping and Air Conditioning, May, 1932, p. 376). Influence of Stack Effect on the Heat Loss in Tall Buildings, by Axel Marin (A.S.H.V.E. TRANSACTIONS, Vol. 40, 1934, p. 377).

⁶Neutral Zone in Ventilating, by J. E. Emswiler (A.S.H.V.E. TRANSACTIONS, Vol. 32, 1926, p. 59).