Class D—85 per cent equipment.—A mechanical system consisting of the following:

1. An accurate air supply with a maximum capacity of 30 c.f.m. per occupant.
2. Gravity exhaust or exhaust openings.
3. Good air distribution.
4. Automatic temperature control.

Class E—80 per cent equipment.

1. A positive air supply with gravity exhaust but without air cleaning devices, humidifying apparatus, temperature or humidity control.
2. Direct-indirect systems with either mechanical or gravity exhaust.
3. Open window or other so-called natural systems of ventilation.

A comprehensive discussion of the requirements of ventilation has been published[1] which suggests the following quantities of air to be supplied, under different conditions, to space used for various purposes as given in Table 90:

TABLE 90. AMOUNT OF NEW AIR TO BE SUPPLIED PER PERSON[1]

	Cubic Feet per Minute			Number of Air Changes per Hour
	Without Humidification or Recirculation	With Humidification but Without Recirculation	With Humidification and Recirculation	
SCHOOLS—				
Class Rooms	30	20	5 to 10	
Assembly Rooms	15 to 20	10 to 15	5 to 10	
Gymnasiums	30	25	15 to 20	
Toilets				10 to 20
Locker Rooms				5 to 10
Kitchens				20 to 60
Lunch Rooms				10 to 20
THEATERS—				
Seating Space	30 to 50	20 to 30	10 to 15	
HOSPITALS—				
Wards	30 to 40	20 to 30		
Kitchens				20 to 60
Dining Rooms				10 to 20
Toilets				10 to 20
HOTELS—				
Dining Rooms				10 to 15
Kitchens				20 to 60
Ball Rooms				5 to 10
Work Space				5 to 10
Assembly Rooms	20 to 30	15 to 20	10 to 15	

VENTILATION REQUIREMENTS

In a crowded place of assemblage the heat given off by the occupants together with that given off by the lighting and power equipment is usually more than the normal heat loss through the structure to the

[1]Modern Trend in the Science of Ventilation, Perry West, TRANSACTIONS, AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, Vol. 30, 1924.

outside air, even in winter under cold climatic conditions. This means that in order to preserve an equilibrium of effective temperature the entering air must be cooler than the leaving air, so that the problem is usually one of cooling and ventilating rather than of heating and ventilating.

A typical case for winter might show about 300 B.t.u. of body heat plus 100 B.t.u. from light etc., being given up to the building against 200 B.t.u. heat loss from the building, per person per hour. This would mean that 200 B.t.u. per person must be carried away by the air (see p. 29, Chapter 1).

If the flow of air is upward, or from the side, so as to bring the incoming air into direct contact with the occupants the temperature of the incoming air should not be more than 5 deg. below the temperature of the air leaving the occupant (for ceilings 10 ft. or less in height) otherwise the ventilation will be drafty and uncomfortable. This difference may be increased 1 deg. for each 2 ft. of added ceiling height provided the rising air does not come into direct contact with another tier of occupants.

For 10 ft. and lower ceilings the quantity of air per person to dissipate this excess heat is $\frac{200}{60 \times .02 \times 5} = 33$ cu. ft. per person per min.

This amount may be reduced somewhat on the assumption that the component of heat from lights is usually introduced near the ceiling and may be allowed to heat the outgoing air to a greater difference.

In the practical work of engineers who design ventilating systems and of architects and owners who have to pass up on these systems, the one item involving standards which is the basis of all calculations and layouts, is the quantity of air to be handled by the system to be used, for producing the results desired. The functions of the air handled in connection with ventilated spaces are: (1) to supply the necessary oxygen for respiration, (2) to keep the dilution of CO_2 and other objectionable substances down to the proper point, and (3) to maintain the proper effective air temperature. It has been estimated that an adult at rest will breathe 0.25 cu. ft. of air per minute and exhale 0.01 cu. ft. of CO_2 in the same period or at the rate of 0.6 cu. ft. per hour, thus removing about 5 per cent of the oxygen from the air breathed. The same air may be rebreathed for a limited time without apparent harmful affect but discomfort is evident. However air may be filtered, washed, cooled and recirculated with evident satisfaction. This was demonstrated under the stimulus of war time conditions and with the development of better equipment.

TABLE 91. AIR REQUIRED FOR VARIOUS PERCENTAGES OF VENTILATION PERFECTION

Percentage of Perfection	Cu. Ft. of Air per Minute Required per Person at Rest	Cu. Ft. of Air per Minute Required per Person at Hard Work
98%	15.0	30.0
96%	7.5	15.0
94%	5.0	10.0
92%	3.75	7.5
90%	3.0	6.0