NATIONAL BUILDING CODE

(Part 8, section 1 lighting and ventilation; subsection 5.2.3.1)

National Building Code – Part 8

5 VENTILATION

5.1 General

Ventilation of building is required to supply fresh air for respiration of occupants, to dilute inside air to prevent vitiation by body odors and to remove any products of combustion or other contaminants in air and to provide such thermal environments as will assist in the maintenance of heat balance of the body in order to prevent discomfort and injury to health of the occupants.

5.2 Design Considerations

5.2.1 Respiration

Supply of fresh air to provide oxygen for the human body for elimination of waste products and to maintain carbon dioxide concentration in the air within safe limits rarely calls for special attention as enough as outside air for this purpose normally enters the areas of occupancy through crevices and other openings.

5.2.1.1 In normal habitable rooms devoid of smoke generating source, the content of carbon dioxide in air rarely exceeds 0.5 to 1 percent and is, therefore incapable of producing any ill effect. The amount of air required to keep the concentration down to 1 percent is very small. The change in oxygen Content is also too small under normal conditions to have any ill effects; the oxygen content may vary quite appreciably with out noticeable effect, if the carbon dioxide concentration is unchanged.

5.2.2 Vitiation by Body Odors

Where no products of combustion or other contaminants are to be removed from air, the amount of fresh air required for dilution of inside air to prevent vitiation of air by body odors, depends on the air space available per person and the degree of physical activity; the amount of air decreases as the air space available per person increases, and it may vary from 20 to 30 m^3 per person per hour. In rooms occupied by only a small number of persons such an air change will automatically be attained in cool weather by normal leakage around windows and other opening and this may easily be secured in warm weather by keeping the openings open.

No standards have been laid down under the factories Act, 1948 as regards the amount of fresh air required per worker of the number of air changes per hour. Section 16 relating to over-crowding requires that at least 14 to 16 m3 of space shall be provided for every worker and for the purpose of that section no account shall be taken of any space in a workroom, which is more than 4.25 m above the floor level.

NOTE- Vitiation of the atmosphere can also occur in factories by odors given off due to contaminants of the product itself, say for example, from tobacco processing in a ‘Bidi’ factory. Here the ventilation will have to be augmented to keep odors within unobjectionable levels.

5.2.2.1 Recommended values for air changes

The standards of general ventilation are recommended / based on maintenance of required oxygen, carbon dioxide and other air quality levels and for the control of body odors when no products combustion or other contaminants are present in the air the values of air changes should be in accordance with the recommendations of part 8 Building services, Section 3 Air conditioning, heating and mechanical ventilation.

5.2.3 Heat Balance of Body

Specially in hot weather, When thermal environment inside the room is worsened by heat given off by machinery, occupants and other sources, the prime need for ventilation is to provide such thermal environment as will assist in the maintenance of heat balance of the body in order to prevent discomfort and injury to health. Excess of heat either from increased metabolism due to physical activity of persons or gains from a hot environment has to be offset to maintain normal body temperature (37oC). Heat exchange of the human body with respect to the surroundings is determined by the temperature and humidity gradient between the skin and the surroundings and other factors, such as age of persons, clothing, etc, and the latter depends on air temperature (dry bulb temperature), relative humidity, radiation from the solid surrounding and rate of air movement. The volume of outside air to be circulated through the room is, therefore, governed by the physical considerations of controlling the temperature, air distribution or air movement. Air movement and air distribution may, however, be achieved by re-circulation of the inside air rather than bringing in all out side air. However, fresh air supply or the circulated air will reduce heat stress by dissipating heat from body by evaporation of the sweat, particularly when the relative humidity is high and the air temperature is near body temperature.

5.2.3.1 Limits of comfort and heat tolerance

Thermal comfort is that condition of thermal environment under which a person can maintain a body heat balance at normal body temperature and without perceptible sweating. Limits of comfort vary considerably according to studies carried out in India and abroad. The thermal comfort of a person lies between TSI values of 25^0C with optimum condition at 27.5 ^{0}C. Air movement is necessary in hot and humid weather for body cooling. A certain minimum desirable wind speed is needed for achieving thermal comfort at different temperatures and relative humidities. Such wind speeds are given in Table 8. These are applicable to sedentary work in offices and other places having no noticeable sources of heat gain. Where somewhat warmer conditions are prevalent such as in godowns and machine shops and work is of lighter intensity, and higher temperatures can be tolerated without much discomfort minimum wind speeds for just acceptable warm conditions are given in Table 9. For obtaining values of indoor wind speed above 2.0 m/s, mechanical means of ventilation may have to be adopted.

Table 8 Desirable wind speeds (m/s) for Thermal Comfort conditions
(Clause 5.2.3.1)

Dry Bulb Temperature, °C	Relative Humidity (Percentage)						
	30	**40**	**50**	**60**	**70**	**80**	**90**
28	∗	∗	∗	∗	∗	∗	∗
29	∗	∗	∗	∗	∗	0.06	0.19
30	∗	∗	∗	0.06	0.24	0.53	0.85
31	∗	0.06	0.24	0.53	1.04	1.47	2.10
32	0.20	0.46	0.94	1.59	2.26	3.04	∗∗
33	0.77	1.36	2.12	3.00	∗∗	∗∗	∗∗
34	1.85	2.72	∗∗	∗∗	∗∗	∗∗	∗∗
35	3.20	∗∗	∗∗	∗∗	∗∗	∗∗	∗∗

∗ None

∗∗ Higher than those acceptable in practice.

Table 9 Minimum Wind speeds (m/s) for Just Acceptable Warm Conditions
(Clause 5.2.3.1)

Dry Bulb Temperature, °C	Relative Humidity (Percentage)						
	30	**40**	**50**	**60**	**70**	**80**	**90**
28	∗	∗	∗	∗	∗	∗	∗
29	∗	∗	∗	∗	∗	∗	∗
30	∗	∗	∗	∗	∗	∗	∗
31	∗	∗	∗	∗	∗	0.06	0.23
32	∗	∗	∗	0.09	0.24	0.60	0.94
33	∗	0.04	0.24	0.06	1.04	1.85	2.10
34	0.15	0.46	0.94	1.60	2.26	3.05	∗∗
35	0.68	1.36	2.10	3.05	∗∗	∗∗	∗∗
36	1.72	2.70	∗∗	∗∗	∗∗	∗∗	∗∗

∗ None

∗∗ Higher than those acceptable in practice.

5.2.3.2 There will be a limit of heat tolerance when air temperatures are excessive and the degree of physical activity is high. This limit is determined when the bodily heat balance is upset, that is, when the bodily heat gain due to conduction, convection and the radiation from the surroundings exceeds the bodily heat lcss, which is mostly by evaporation of sweat from the surface of the body. The limits of heat tolerance for Indian workers are based on the study conducted by the chief Adviser Factories, Government of India, Ministry of Labour and are given in his report on Thermal Stress in Textile Industry (Report No.17) issued in 1956. According to this Report, where workers in industrial buildings wearing light clothing are expected to do work of moderate severity with the energy expenditure in the range 273 to 284 watt, the maximum wet bulb temperature shall not exceed 290C and adequate air movement subject to a minimum air velocity of 30 m/min shall be provided, and in relation to the dry bulb practicable, shall not exceed that given in Table 10.

Table 10 Maximum permissible wet Bulb Temperatures for Given Dry Bulb Temperatures
(Clause 5.2.3.2)

Dry Bulb Temperature ^{o}C	Maximum Wet-Bulb Temperature ^{o}C
30	29.0
35	28.5
40	28.0
45	27.5
50	27.0

NOTES:

1. These are limits beyond which the industry should not allow the thermal conditions to go for more than 1h continuously. The limits are based on a series of studies conducted on Indian subjects in psychometric chamber and on other data on heat causalities in earlier studies conducted in Kolar Gold Fields and elsewhere.

2. Figure given in this table are not intended to convey that human efficiency at 50^{o}C will remain the same as at 30^{o}C, provided appropriate wet bulb temperatures are maintained. Efficiency decreases with rise in the dry bulb temperatures as well, as much as possible. Long exposures to temperature of 50^{o}C dry bulb 27^{o}C wet bulb may prove dangerous.

3. Refrigeration or some other method of cooling is recommended in all cases where conditions would be worse than those shown in this table.