

effective temperature for sedentary persons, as determined at the A.S.H.V.E. Research Laboratory, is 66 deg.

As explained in Chapter 2 for so-called still air conditions, a relative humidity of approximately 50 per cent is required to produce an effective temperature of 66 deg when the dry-bulb temperature is 70 F. However, even where provision is made for artificial humidification, the relative humidity is seldom maintained higher than 40 per cent during the extremely cold weather, and where no provision is made for humidification, the relative humidity may be 20 per cent or less. Consequently, in using the figures listed in Table 1, consideration should be given to whether

TABLE 1. WINTER INSIDE DRY-BULB TEMPERATURES USUALLY SPECIFIED^a

TYPE OF BUILDING	DEG F	TYPE OF BUILDING	DEG F
SCHOOLS—		THEATERS—	
Class rooms.....	70-72	Seating space.....	68-72
Assembly rooms.....	68-72	Lounge rooms.....	68-72
Gymnasiums.....	55-65	Toilets.....	68
Toilets and baths.....	70		
Wardrobe and locker rooms.....	65-68	HOTELS—	
Kitchens.....	66	Bedrooms and baths.....	70
Dining and lunch rooms.....	65-70	Dining rooms.....	70
Playrooms.....	60-65	Kitchens and laundries.....	66
Natatoriums.....	75	Ballrooms.....	65-68
		Toilets and service rooms.....	68
HOSPITALS—		HOMES.....	70-72
Private rooms.....	70-72	STORES.....	65-68
Private rooms (surgical).....	70-80	PUBLIC BUILDINGS.....	68-72
Operating rooms.....	70-95	WARM AIR BATHS.....	120
Wards.....	68	STEAM BATHS.....	110
Kitchens and laundries.....	66	FACTORIES AND MACHINE SHOPS.....	60-65
Toilets.....	68	FOUNDRIES AND BOILER SHOPS.....	50-60
Bathrooms.....	70-80	PAINT SHOPS.....	80

^aThe most comfortable dry-bulb temperature to be maintained depends on the relative humidity and air motion. These three factors considered together constitute what is termed the *effective temperature*. (See Chapter 2.)

provision is to be made for humidification, and if so, the actual relative humidity to be maintained.

Temperature at Proper Level: In making the actual heat loss computations, however, for the various rooms in a building it is often necessary to modify the temperatures given in Table 1 so that the air temperature at the proper level will be used. By *air temperature at the proper level* is meant, in the case of walls, the air temperature at the mean height between floor and ceiling; in the case of glass, the air temperature at the mean height of the glass; in the case of roof or ceiling, the air temperature at the mean height of the roof or ceiling above the floor of the heated room; and in the case of floors, the air temperature at the floor level.

Temperature at Ceiling: The air temperature at the ceiling is generally higher than at the breathing level due to stratification of air resulting from the tendency of the warmer or less dense air to rise. An allowance for this fact should be made in calculating ceiling heat losses, particularly in the

case of high ceilings. However, the exact allowance to be made may be somewhat difficult to determine as it depends on many factors, including (1) the type of heating system, (2) ceiling height and (3) the inside-outside temperature differential. The type of heating system is particularly important as the temperature gradient from floor to breathing-level to ceiling may depend to a large extent on whether direct radiation, unit heaters or warm air is used, and in the latter case, whether the circulation is by gravity, auxiliary fan or forced air. Although with properly adjusted air flow the temperature differential with unit heaters can be

TABLE 2. APPROXIMATE TEMPERATURE DIFFERENTIALS BETWEEN BREATHING LEVEL AND CEILING, APPLICABLE TO CERTAIN TYPES OF HEATING SYSTEMS^a

CEILING HEIGHT (FT)	BREATHING LEVEL TEMPERATURE (5 FT ABOVE FLOOR)									
	60	65	70	72	74	76	78	80	85	90
10	3.0	3.3	3.5	3.6	3.7	3.8	3.9	4.0	4.3	4.5
11	3.6	3.9	4.2	4.3	4.4	4.6	4.7	4.8	5.1	5.4
12	4.2	4.6	4.9	5.0	5.2	5.3	5.5	5.6	6.0	6.3
13	4.8	5.2	5.6	5.8	5.9	6.1	6.2	6.4	6.8	7.2
14	5.4	5.9	6.3	6.5	6.7	6.8	7.0	7.2	7.7	8.1
15	6.0	6.5	7.0	7.2	7.4	7.6	7.8	8.0	8.5	9.0
16	6.1	6.6	7.1	7.3	7.5	7.7	7.9	8.1	8.6	9.1
17	6.2	6.7	7.2	7.4	7.6	7.8	8.0	8.2	8.7	9.2
18	6.3	6.8	7.3	7.5	7.7	7.9	8.1	8.3	8.8	9.3
19	6.4	6.9	7.4	7.6	7.8	8.0	8.2	8.4	8.9	9.4
20	6.5	7.0	7.5	7.7	7.9	8.1	8.3	8.5	9.0	9.5
25	7.0	7.5	8.0	8.2	8.4	8.6	8.8	9.0	9.5	10.0
30	7.5	8.0	8.5	8.7	8.9	9.1	9.3	9.5	10.0	10.5
35	8.0	8.5	9.0	9.2	9.4	9.6	9.8	10.0	10.5	11.0
40	8.5	9.0	9.5	9.7	9.9	10.1	10.3	10.5	11.0	11.5
45	9.0	9.5	10.0	10.2	10.4	10.6	10.8	11.0	11.5	12.0
50	9.5	10.0	10.5	10.7	10.9	11.1	11.3	11.5	12.0	12.5

^aThe figures in this table are based on an increase of 1 per cent per foot of height above the breathing level (5 ft) up to 15 ft and 1/10 of one degree for each foot above 15 ft. This table is generally applicable to forced air types of heating systems. For direct radiation or gravity warm air, increase values 50 per cent to 100 per cent.

reduced to a minimum, it is also possible with improper adjustment that the temperature differential will be increased over that which would normally result without mechanical circulation of the air.

Tests in the University of Illinois Research Residence¹ indicated that the breathing level-ceiling temperature differential varied from about 1 to 3½ deg for three types of warm air heating systems, namely, forced air, auxiliary fan and gravity. These tests were based on an outdoor air temperature of approximately 20 F. Tests in the University of Wisconsin Field House² having a ceiling height of 97 ft showed a temperature gradient of about ¾ deg per foot for the first 15 ft of elevation and

¹University of Illinois Engineering Experiment Station Bulletin No. 318—Investigation of Oil-Fired Forced Air Furnace Systems in the Research Residence, by A. P. Kratz and S. Kouzo.

²A.S.H.V.E. RESEARCH REPORT No. 958—Temperature Gradient Observations in a Large Heated Space, by G. L. Larson, D. W. Nelson, and O. C. Cromer (A.S.H.V.E. TRANSACTIONS, Vol. 39, 1933, p. 243).