movement consistently increases evaporative cooling, and therefore heat tolerance, when relative humidity is high and air temperature low. When relative humidity is low and air temperature is high, however, an increase in air velocity from 17 to 30 or 100 fpm actually decreases heat tolerance. Under these conditions air temperature is above skin temperature and the increased demand for evaporative cooling exceeds the actual increase of evaporation due to the higher air movement. When an air velocity of 500 fpm is reached, the limits of the zone are broadened throughout its range. For very hot and dry environments, still air is more desirable than a slightly greater air movement but a high air movement is still better.

At low air temperatures the effect of increased air movement upon convection loss is a simple and direct one; but the exact quantitative influence of air movement upon the rate of cooling of a hot body has, until recently, been unknown. Studies at the *John B. Pierce Laboratory of Hygiene*, as yet unpublished, have indicated that the cooling effect of air actually increases as the square root of its velocity. Under the conditions

TABLE 6. PERCENTAGE OF TOTAL HEAT LOSS EFFECTED BY THE THREE CHIEF ROUTES OF THERMAL INTERCHANGE

Air Temperature	Deg F	60			70			80			90		
Air Movement	fpm	15	100	250	15	100	250	15	100	250	15	100	250
Evaporation	per cent	18	16	15	22	19	18	29	27	25	73	67	55
Radiation	per cent	43	26	19	40	26	17	37	24	17	14	10	13
Convection	per cent	39	58	66	38	55	65	34	49	58	13	23	32

of the experiments in question (semi-reclining lightly clothed subjects) the effect is represented by the formula:

$$\frac{C}{\Delta T} = 0.413\sqrt{V}, \qquad (2)$$

where

C = Convection loss in kilogram-calories per square meter of body surface per hour.

ΔT = Surface temperature of the body (clothing and exposed skin) minus air temperature, degrees Fahrenheit.

V = Velocity of air, feet per minute.

The extent of the effect may be indicated by the computed data in Table 7.

As emphasized in an earlier paragraph the problem of local drafts causing differential cooling of special areas of the body is one that must always be kept in mind. Experience, and recent field studies by the A.S.H.V.E. Research Laboratory[51] place the desirable air movement between 15 and 25 fpm under ordinary room temperatures during the heating season. Objectionable drafts are likely to occur when the velocity

[51]A.S.H.V.E. RESEARCH REPORT No. 1016—Classroom Drafts in Relation to Entering Air Stream Temperature, by F. C. Houghten, H. H. Trimble, Carl Gutberlet, and M. F. Lichtenfels (A.S.H.V.E. TRANSACTIONS, Vol. 41, 1935, p. 268).

of the air current is 40 fpm and the temperature of the air current 2 F or more below the customary winter room temperature. Higher velocities are desirable in the summer time when the air temperature exceeds 80 F. Variations in air movement and temperature in different parts of occupied rooms are often indicative of relative air distribution. The work of the A.S.H.V.E. Research Laboratory indicates that an air movement between 15 and 25 fpm with a temperature variation of 3 F or less in different parts of a room, 36 in. above floor, represent satisfactory distribution.

THE FOUR VITAL FACTORS

From the preceding discussion it is clear that thermal environment cannot properly be adjusted to the requirements of human health and comfort without control of all the four basic factors concerned.

According to the recommendations of the Sub-Committee on the Hygiene of Environmental Conditions in the Dwelling[52], it is of great

TABLE 7. CORRESPONDING EQUIVALENT AIR TEMPERATURES PRODUCING EQUAL HEAT LOSS AT 15 FPM FOR VARIOUS AIR TEMPERATURES AND AIR MOVEMENTS

OBSERVED AMBIENT AIR TEMPERATURE DEG F	EQUIVALENT TEMPERATURE AT STANDARD AIR MOVEMENT OF 15 FPM WHEN OBSERVED AIR MOVEMENT IS			
	15 fpm	100 fpm	250 fpm	500 fpm
95	95	95.0	95.7	96.0
90	90	88.5	87.7	87.0
85	85	81.7	79.5	78.0
80	80	75.2	71.6	69.0
75	75	68.7	63.5	60.3
70	70	62.2	55.5	51.2
65	65	55.5	47.5	42.5
60	60	48.9	39.5	33.6
55	55	42.3	31.8	24.7
50	50	35.7	23.5	15.8

importance in all research studies to make an accurate record of each of the four independent factors governing bodily heat exchanges, temperature, movement and humidity of the air, and mean radiant temperature of the surrounding surfaces. For this purpose the committee suggested in the interest of comparability the use of the following four types of instruments or others yielding similar data:

1. Silvered dry-bulb thermometers or hair-pin thermometers (Bargeboer).
2. Silvered dry Kata-thermometers or the hot wire anemometer.
3. Psychrometer, wet- and dry-bulb, whirling or ventilated.
4. Globe thermometer (Vernon) or the dry resultant thermometer (Missenard).

Such instruments as these, when properly calibrated and their readings are compared, can be used for determining the four basic physical factors concerned separately or in certain combinations. The results of the four physical measurements thus determined can generally be translated into the terms of any special instrument combining two or more of them.

[52]Housing Commission of the League of Nations, adopted at Geneva, June 25, 1937.