3. As one proceeds to higher operative temperatures, the heat received from the environment due to radiation plus convection increases progressively but is exactly balanced by a similarly progressive increase in evaporative heat loss, so that no further negative storage (warming of the body) takes place. At an operative temperature of 100 F the body is gaining 10 kilogram-calories from the combined influence of walls and air, and this heat gain plus the metabolic heat produced is balanced by a heat loss of 60 kilogram-calories due to evaporation.

4. Below the critical temperature of 85 F the phenomena are wholly different. Evaporative heat loss here changes but slightly, falling from 20 to 10 kilogram-calories per hour as the operative temperature decreases, as a result chiefly of the purely physical factor of decreasing vapor pressure difference between skin and air. In this zone, heat loss due to the combined influence of radiation plus convection increases progressively (although the slope of the line is less rapid than above 85 F). Since this progressively increasing heat loss is not balanced, there is a parallel increase in storage (cooling of the body tissues).

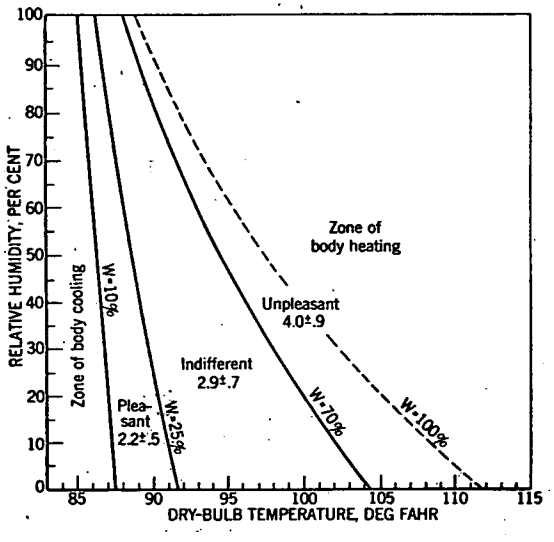


FIG. 2. CONTOUR CHART INDICATING LIMITING WETTED AREAS ASSOCIATED WITH CERTAIN SENSATIONS OF PLEASANTNESS (IN THE ZONE OF EVAPORATIVE REGULATION) IN RELATION TO AIR TEMPERATURE AND RELATIVE HUMIDITY. OBSERVED MEAN COMFORT VOTES ARE INDICATED IN EACH REGION. (UNCLOTHED SUBJECTS.)

Localized drafts are important since differential cooling of one area of the body may produce surprisingly unpleasant reactions in quite different parts of the body. In a recent experiment[10] it was shown that the application of an ice pack to an area of 60 sq cm on the back of the neck for 15 min caused a drop of 17 F in the skin temperature of the fingers and that this low temperature of the fingers persisted for one hour after the ice pack was removed.

[10]The Relative Influence of Radiation and Convection Upon the Temperature Regulation of the Clothed Body, by C.-E. A. Winslow, L. P. Herrington, and A. P. Gagge (*American Journal of Physiology*, Vol. 124, October, 1938, p. 51).

ADAPTATION TO HOT CONDITIONS

Within a certain thermal region on the hot side of the optimum, the body can balance increases in air or wall temperature by increasing secretion of sweat. The body can balance changes in relative humidity within this zone just as precisely as it can balance changes in temperatures, up to the point where the sweat no longer evaporates but runs off without exerting its cooling power. Until the latter point is reached, evaporative heat loss, at a given air temperature, is exactly the same whether humidity be high or low.

It is important to note, however, that even in the range where this type of adaptation is thermally adequate, the process of sweat secretion is associated with sensations of marked discomfort. It has been demonstrated that *wetted area*, the physiological index of sweat secretion, shows a correlation of 0.65 ± 0.006 with expressions of discomfort[11]. Further-

TABLE 2. UPPER LIMITS OF EVAPORATIVE REGULATION
(*Clothed Subject*)

ENVIRONMENTAL TEMPERATURE		RELATIVE HUMIDITY PER CENT
Deg F	Deg C	
126.9	52.7	0
122.0	50.0	5
113.0	45.0	18
108.5	42.5	26
104.5	40.0	38
99.5	37.5	51
95.0	35.0	69
90.5	32.5	89
87.8	31.0	100

more, there develops, even under moderate conditions of overheating, a definite disclination for physical activity. The *New York State Commission* found that experimental subjects performed 28 per cent less work at 86 F with 80 per cent relative humidity than at 68 F with 50 per cent relative humidity[12].

The upper limit of this *zone of evaporative regulation* is, of course, established by the combination of air and wall temperature, relative humidity and air movement beyond which the sweat runs off without evaporation and cooling of the body surface. Limits for unclothed, semi-reclining subjects, with minimal air movement are shown in Fig. 2. Studies at the *John B. Pierce Laboratory of Hygiene* have established the upper limits of evaporative regulation for the clothed, semi-reclining body at an air movement of 17 fpm as shown in Table 2[13].

Since 1922 notable progress has been made by the A.S.H.V.E. Research Laboratory in fixing corresponding upper limits for subjects engaged in

[11]Relations Between Atmospheric Conditions, Physiological Reactions, and Sensations of Pleasantness, by C.-E. A. Winslow, L. P. Herrington, and A. P. Gagge (*American Journal of Hygiene*, Vol. 26, July, 1937, p. 102).

[12]Ventilation Report of the New York State Commission on Ventilation (E. P. Dutton Co., N. Y., 1923).

[13]The Reactions of the Clothed Human Body to Variations in Atmospheric Humidity, by C.-E. A. Winslow, L. P. Herrington, and A. P. Gagge (*American Journal of Physiology*, Vol. 124, December, 1938, p. 692).