EFFECTIVE TEMPERATURE INDEX AND COMFORT ZONES

There is no precise physiologic observation by which comfort can be evaluated. Mean skin temperature offers some promise. The zone of thermal neutrality differs with clothing, season, activity, and all the other factors controlling heat production (Table 4). The comfort zone is very similar to the zone of thermal neutrality.

Sensations of warmth or cold depend not only on the temperature of the surrounding air as registered by a dry-bulb thermometer, but also upon the temperature indicated by a wet-bulb thermometer, upon air movement, and upon radiation effects. Dry air at a relatively high temperature may feel cooler than air of lower temperature with a high moisture content. Air motion makes any moderate condition feel cooler. Radiation to cold or from warm surfaces is another important factor under certain conditions affecting the comfort reaction of the individual.

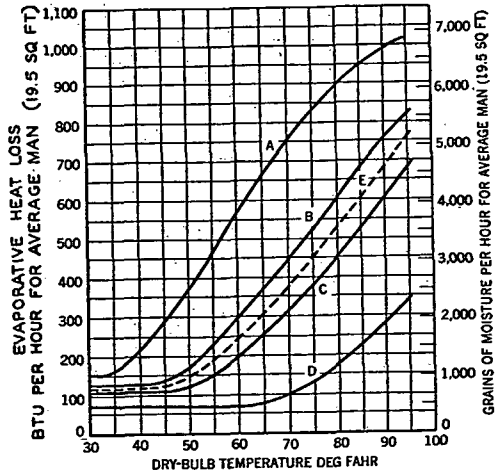

FIG. 7. EVAPORATIVE HEAT AND MOISTURE LOSS FROM THE HUMAN BODY IN RELATION TO DRY-BULB TEMPERATURE FOR STILL AIR CONDITIONS[a 14]

[a] See footnote a, Fig. 5.

Combinations of temperature, humidity, and air movement which induce the same feeling of warmth are called thermo-equivalent conditions. A series of studies[22] at the A.S.H.A.E. Research Laboratory established the equivalent conditions for practical use. This scale of thermo-equivalent conditions not only indicates the sensation of warmth, but also to a considerable degree determines the physiological *effects* on the body induced by heat or cold. For this reason, it is called the *effective temperature* scale or index, and it denotes sensory heat level.

Effective temperature is an empirically determined index of the degree of warmth perceived on exposure to different combinations of temperature, humidity, and air movement. It was determined by trained subjects who compared the relative warmth of various air conditions in two adjoining conditioned rooms by passing back and forth from one room to the other.

The numerical value of the index for any given air conditions is fixed by the temperature of slowly moving (15 to 25 fpm air movement) saturated

air which induces a like sensation of warmth or cold. Thus, any air condition has an effective temperature of 60 deg when it induces a sensation of warmth like that experienced in slowly moving air at 60 F saturated with moisture. The *effective temperature index* cannot be measured directly, but is determined from dry- and wet-bulb temperatures and air motion observations by reference to an Effective Temperature Chart (see Figs. 8, 9, and 10) or tables.

Fig. 8 gives the effective temperature for any combination of dry- and wet-bulb temperatures for *still air* (15 to 25 fpm) conditions. Charts similar to Fig. 8 for air velocities of 100 and 300 fpm have been presented in earlier editions of THE GUIDE, *e.g.* 1939. Fig. 9 is another form of effective temperature chart embodying all three variables: dry-bulb and wet-bulb temperatures, and air velocity.

TABLE 4. COMPARISON OF COMFORT RANGES WITH ZONE OF THERMAL NEUTRALITY

INVESTIGATORS	EFFECTIVE TEMPERATURE		OPERATIVE TEMP	REMARKS
	OPTIMUM LINE	RANGE	RANGE	
Comfort Zone				
Houghten and Yaglou	66	63–71	.....	Winter non-basal; at rest, normally clothed. Men and women.
Yaglou and Drinker	71	66–75	.....	Summer non-basal; at rest and normally clothed. Men.
Yaglou	72.5	66–82	.....	Entire year; non-basal; at rest and stripped to waist. Men.
Keeton et al	75	74–76	.....	Entire year; basal, nude. Steady state (9 hr exposure). Men and women.
Zone of Thermal Neutrality				
DuBois and Hardy	75	73.2–76.9	.....	Basal; nude; men.
Winslow, Herrington and Gagge	71.8	64.8–76.0	.....	Basal; clothed; men.
	.....	.....	84.0–87.8	Non-basal; at rest; nude; men.
	.....	.....	74 –84	Non-basal; at rest; clothed; men.

As stated previously, effective temperature is an index of the degree of warmth experienced by the body. An effective temperature line is, therefore, a line defining the various combinations of conditions which will induce like sensations of warmth. It does not necessarily follow that like sensations of comfort will also be experienced along the entire length of an effective temperature line. Some degree of discomfort is likely to be experienced at very high or very low relative humidities, regardless of the effective temperature. It has also been found that the optimum effective temperature varies with the season, and is lower in winter than in summer.

Tests[14] made at the A.S.H.A.E. Research Laboratory in very hot conditions, with subjects doing light work, were in very close agreement with the effective temperature chart. Other work[20] under similar environmental conditions, but with subjects walking 3 mph and carrying 20 lb packs, indicated that the effective temperature lines should be more