Table 2 .... High Environmental Dry- and Wet-Bulb Temperatures* That Can Be Tolerated in Daily Work by Healthy, Acclimatized Men Wearing Warm Weather Clothing

Activity	Relative Humidity %	Air Movement 15–25 fpm Dry Bulb	15–25 fpm Wet Bulb	100 fpm Dry Bulb	100 fpm Wet Bulb	300 fpm Dry Bulb	300 fpm Wet Bulb
Summer season	80	89	84	91	85	93	87
Light sedentary	60	94	82	96	84	98	85
activities	40	100	79	101	81	103	82
(85 ET)	20	109	75	110	75	110	75
	5	119	69	118	69	117	68
Summer season	80	83	78	86	81	89	83
Heavy Work	60	88	76	90	78	93	80
(80 ET)	40	93	73	95	75	97	76
	20	100	69	101	70	102	70
	5	107	64	107	64	106	63
Winter season	80	78	73	81	77	85	79
Light or heavy	60	81	71	85	74	88	76
work	40	86	68	89	70	91	72
(75 ET)	20	91	63	93	65	94	66
	5	97	58	97	58	97	59

* Including radiation effect. (Reprinted by permission of Committee on Industrial Ventilation, American Conference of Governmental Industrial Hygienists.)

als differ widely in their capacity to acclimatize. Men lose most of their acclimatization characteristics in a few weeks of temperate climate, even though they are vigorously active. In the course of acclimatization, the sweat glands come to secrete fluid less rich in salt.[22] For all men except those carrying out really hard work in hot, dry atmospheres, this effects an important reduction in salt loss, and makes the difference between being and not being subject to the risk of heat cramps.

The adaptive level changes somewhat with the season. There are also marked differences between the sexes. In the cold zone, the thickness of the thermal insulating tissues of women is almost double that of men, although the sensory responses to cold are similar. In the hot zone, the threshold of sweating is higher for women. The thickness and insulating value of the clothing worn are also important factors in the determination of the comfort level.

UPPER LIMITS OF HEAT FOR MEN AT WORK

Hot Spaces

In some industries it is impossible, due to process requirements, to maintain optimum conditions of comfort. Unless the whole process can be mechanized or isolated, the problem resolves itself into one of alleviating conditions of discomfort to the greatest extent feasible. Several approaches are possible: (1) insulate the source of heat, (2) reduce temperature by bringing in cool air, (3) reduce humidity, e.g., vent steam generated to the outside, (4) strip down to minimum amount of clothing suitable for the job, (5) limit hours of exposure, and (6) condition men to the assignment, i.e., employ heat adaptation. All these factors will assist in maintaining efficiency without impairing health.

Table 2 summarizes the conditions under which young, healthy individuals are capable of working and maintaining heat balance provided the metabolic rate is not excessive, i.e., above 88 Btu per (sq ft) (hr).

Long-continued exposure is known to lead to deterioration of performance and morale even in the most fit and well-acclimatized individuals. Any safe limits that may be set must, therefore, allow for a wide margin of safety to be generally acceptable. Where exposure to heat beyond the limits shown in Table 2 is necessary, short periods of work should be alternated with resting periods in a cooler environment. The length of recovery periods in a relatively cool environment will depend upon the rate and duration of work, the severity of heat, and individual constitutional factors. As a rule, the workers themselves set the pace and length of recovery period in industries. Reference should be made to Fig. 6 to determine safe periods of exposure for extreme environmental temperature. Fig. 6 is based upon the average time required to raise the pulse rate 50 points from an initial rate of about 75 to 125, and the rectal temperature to 101 F from initial levels of 98 to 99 F. Symptoms of heat distress do not appear until the pulse rate exceeds 130 and the rectal temperature 101 F, in exposure lasting more than 1 hr.

In mines where temperatures approach 95 F, with humidities close to the saturation point, men work one-half to one-third of the shift time, alternating short periods of work in the

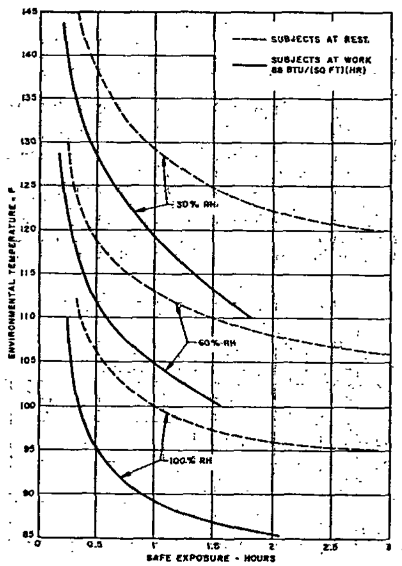
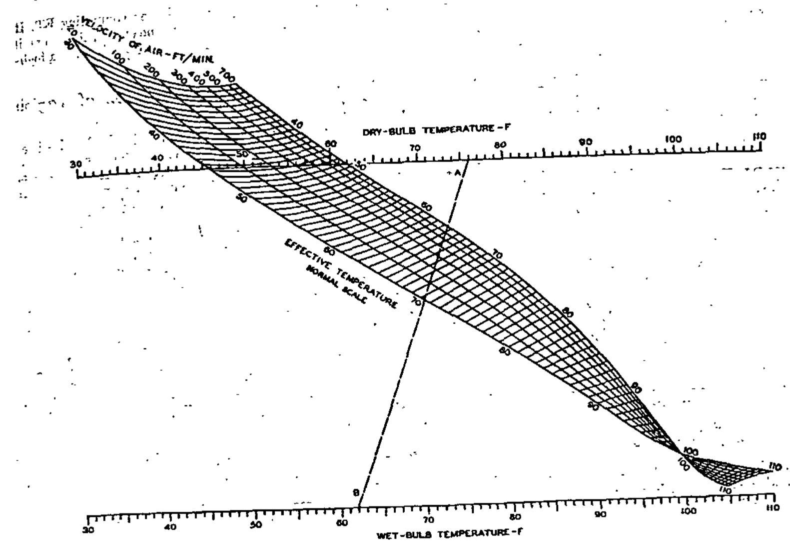


Fig. 6 .... Safe Periods of Exposure for Extreme Environmental Temperatures



A. Clothing: Customary indoor clothing. B. Activity: Sedentary or light muscular work. C. Heating Methods: Convection type, i.e., warm air, direct steam or hot water radiators, plenum systems.

Fig. 7 .... Effective Temperature Chart Showing Normal Scale of Effective Temperature, Applicable to Inhabitants of the United States Under Conditions Stated

heat with rest periods of 40 to 45 min in cooler areas. In aluminum and steel manufacturing processes, in which en- vironmental temperatures between 120 and 160 F with rela- tive humidities of 3 to 15 percent (ET = 90 to 100 F) are en- countered, men doing light duties work for about 1 hr and rest for an equal period, while those engaged in heavy occupations work for about 30 min and rest during the next 30 min.

Sometimes men have to be exposed to temperatures as high as 300 F, near kilns, in front of open furnaces, or in experimental laboratories, but only for 2 to 3 min at a time. Since air cannot be breathed at temperatures higher than 240 F, it is necessary to protect the upper respiratory passages as well as the eyes and hands, if hot objects must be handled.

Assessment of Heat Stress

The thermal load to which man is subjected in a hot environment is the sum of the environmental heat load and the metabolic load. There are a number of indices which may be used to assess (measure) heat stress, but no single index seems to be foolproof at present. Two of the older indices still in use and still valuable in making a first approximation are the Effective Temperature Index (ET) and the Robinson Index of Physiological Effect (*Ep*). Recently, two other indices were developed, namely, the Predicted Four-Hour Sweat Rate Index (P4SR) and the Belding-Hatch Heat Stress Index (HSI). There is presently no one proven method for combining all of the component heat loads into a single value that would accurately indicate the degree of heat stress as perceived by an individual working or resting in a hot environment. The difficulty lies in the inability to simulate human response. Physical instruments can accurately integrate, but the human body has the ability to differentiate between component thermal effects and to make prompt adaptive changes which the instruments cannot do. Nonetheless, each of the indices will supply valuable information on which to base an informed opinion. The index or indices selected for use should depend upon the nature and extent of the problem, the equipment and facilities at hand, and the availability of personnel trained in the field of thermal stress.

Dry-Bulb Temperature

For practical purposes, the best index of warmth under ordinary room conditions with still air is the reading obtained with the dry-bulb thermometer.

Effective Temperature (ET)

Effective Temperature (ET) is an empirical sensory index, combining into a single value the thermal effect of tempera-