20 lb packs under a wide range of environmental conditions which were rated as relatively easy, difficult, and impossible, on the basis of the physiological reactions of the subjects at the end of the 4-hr period as shown in Table 3 and Fig. 3.

Recognition of the need of air conditioning for workers in hot industries is growing rapidly. The choice of the type of system to be used in any given instance, must be determined by the air conditioning engineer after a study of conditions. In some hot industries where few workers are engaged in large spaces the worker himself, rather than the atmosphere, can be cooled by placing him in a small booth, and blowing cooled air over him, or by circulating cooled air through a loose-fitting suit.[21]

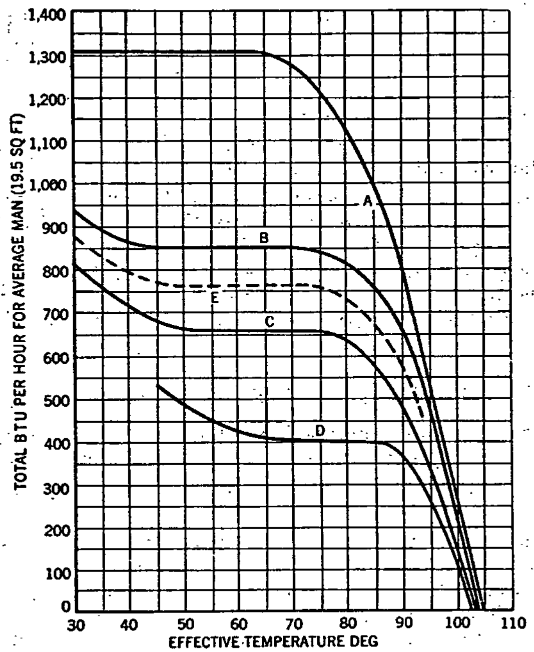

FIG. 5. RELATION BETWEEN TOTAL HEAT LOSS FROM THE HUMAN BODY AND EFFECTIVE TEMPERATURE FOR STILL AIR[a] [14]

[a] Curve *A*—Persons working, metabolic rate 1310 Btu per hour. Curve *B*—Persons working, metabolic rate 850 Btu per hour. Curve *C*—Persons working, metabolic rate 660 Btu per hour. Curve *D*—Persons seated at rest, metabolic rate of 400 Btu per hour. Curves *B* and *D* based on test data covering a wide temperature range. Curves *A* and *C* based on test data at an Effective Temperature of 70 and extrapolation of Curves *B* and *D*. All curves are averages of values for high and low relative humidities; variation due to humidity is small.

The A.S.H.V.E. Laboratory has studied the effects of walls of higher temperature than the air.[18] The findings are in part shown in Fig. 4. It will be seen that the importance of mean radiant temperature, as compared with that of the effective temperature, decreases as the effective temperature rises; and also, to a certain extent, as the mean radiant temperature itself rises. The lower of the two curves relates to conditions in which the MRT was kept approximately at the level of the DBT. If this curve is followed, it will be seen that, at 80 ET, a little more than 1 deg rise in MRT produces the same effect as 1 deg rise in ET; but when the ET is 92 deg, it takes a rise of 11 F deg in the MRT to produce the same effect as 1 deg rise in ET. The upper curve relates to conditions in which the MRT was kept about 40 F deg higher than the DBT. It will be seen that under these conditions, a rise in MRT is less effective, even at low values of ET; and that it loses its relative effectiveness more rapidly as the ET rises. It should not be assumed, however, that MRT does not matter much. All that these comparisons indicate is that unit rise in MRT becomes less important *as compared with unit rise in ET*, as conditions get hotter. This may be due more to a growing importance of unit rise in ET than to a diminishing importance of unit rise in MRT. Under ordinary *still air* conditions the effects of air temperature and MRT appear to be interdependent. Various authorities give 0.3 to 1 deg increase of room temperature to compensate for 1 deg depression of the MRT.

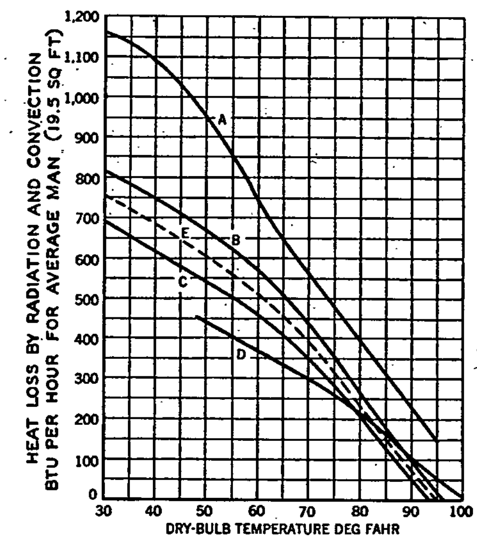

FIG. 6. RELATION BETWEEN RADIATION AND CONVECTION LOSS FROM THE HUMAN BODY AND DRY-BULB TEMPERATURE FOR STILL AIR[a] [14]

[a] Loc. Cit. See footnote a, Fig. 5.

APPLICATION OF PHYSIOLOGIC PRINCIPLES TO AIR CONDITIONING PROBLEMS

In order to estimate cooling loads in occupied spaces it is necessary to know the metabolic rate (heat production) of man. This has been studied extensively, and found to remain relatively constant per unit of body surface area in a subject fasting and resting quietly after a good night's sleep. The rate is high in children, and diminishes gradually with age; it increases in certain diseases and in the presence of fever. The metabolic rate is somewhat lower in women. Heat production goes up sharply with work and varies widely in different persons doing the same work. Figs. 5, 6, and 7 and Table 28 of Chapter 12 give sufficient basic data for estimating heat production and heat loss under various conditions.