Table 3. Relation Between Metabolic Rate and Activity[25]

Activity	Metabolic Rate Btu per Hour for Average Man (19.5 Sq Ft Surface Area)	Authority
Seated at rest	384	Research Laboratory, American Society of Heating and Ventilating Engineers.
Standing at rest	431	Research Laboratory, American Society of Heating and Ventilating Engineers.
Walking 2 mph	761	Average values from Douglas, Haldane, Henderson and Schneider; and Henderson and Haggard.
Walking 3 mph	1049	Douglas, Haldane, Henderson and Schneider
Walking 4 mph	1388	Average values from Douglas, Haldane, Henderson and Schneider; and Henderson and Haggard.
Walking 5 mph	2530	Douglas, Haldane, Henderson and Schneider
Slow run	2285	Henderson and Haggard
Very severe exercise	2555	Benedict and Carpenter
Maximum exertion	3333 to 4762+	Henderson and Haggard
Tailor	482	Becker and Hamalainen
Bookbinder	626	Becker and Hamalainen
Shoemaker	661	Becker and Hamalainen
Carpenter	762 to 963	Becker and Hamalainen
Metal worker	862	Becker and Hamalainen
Painter (of furniture)	876	Becker and Hamalainen
Stonemason	1488	Becker and Hamalainen
Man sawing wood	1797	Becker and Hamalainen

means. It is true that many suggestions have been advanced to account for the stimulating quality of outdoor air, such as ultra-violet light and ionization. At the present time neither of these suggestions has received any degree of scientific confirmation.

It is generally recognized that total outdoor solar radiation has marked curative value in certain diseases and is also a powerful germicidal agent. A critical review of the literature, however, does not substantiate the theory that ultra-violet radiation is of importance in air conditioning, since the use of ultra-violet sources fails to produce indoors, the previously mentioned stimulating qualities found in outdoor air.

Experiments[35] show that in occupied rooms there is a marked decrease in both positive and negative small ions. As shown in Fig. 5, soon after the occupants assembled the ionic content fell abruptly to a very low level which was maintained until the occupants left the room. Both positive and negative ions began to rise again as soon as the occupants departed.

The effects of the decrease in the ionic content of indoor air on comfort and health have not yet been subjected to sufficient scientific investigation. It would appear, however, from the evidence at hand, that comfort is not associated with a high ion content—but this must be considered, at least for the time being, as still a subject for further study.

[35]A.S.H.V.E. research paper entitled Changes in Ionic Content in Occupied Rooms, Ventilated by Natural and Mechanical Methods, by C. P. Yaglou, L. C. Benjamin and S. P. Choate (A.S.H.V.E. Transactions, Vol. 37, 1931). Physiologic Changes During Exposure to Ionized Air, by C. P. Yaglou, A. D. Brandt and L. C. Benjamin (A.S.H.V.E. Journal Section, *Heating, Piping and Air Conditioning*, August, 1933). Diurnal and Seasonal Variations in the Small Ion Content of Outdoor and Indoor Air, by C. P. Yaglou and L. C. Benjamin, (A.S.H.V.E. Journal Section, *Heating, Piping and Air Conditioning*, January, 1934). The Nature of Ions in Air and their Possible Physiological Effects, L. B. Loeb (A.S.H.V.E. Journal Section, *Heating, Piping and Air Conditioning*, October, 1934).

HEAT AND MOISTURE LOSSES

In order to solve air conditioning problems involving the human body it is necessary to know the rate at which sensible and latent heat are given up by the body under various conditions of temperatue and activity. Research at the A.S.H.V.E. Laboratory[32, 36] has resulted in the data given in Figs. 7, 8, and 9. Table 3 gives the metabolic rates for various degrees of activity.

The experimental data from which the curves were drawn show that

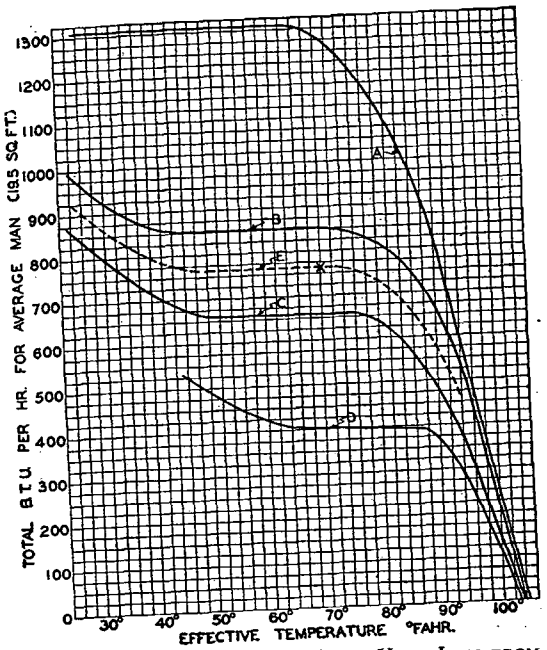

Fig. 6. Relation Between Total Heat Loss from the Human Body and Effective Temperature for Still Air[a]

[a]Curve *A*—Men working 66,160 ft-lb per hour. Curve *B*—Men working 33,075 ft-lb per hour. Curve *C*—Men working 16,538 ft-lb per hour. Curve *D*—Men seated at rest. Curves *A* and *C* drawn from data at an effective temperature of 70 deg only and extrapolating the relation between curves *B* and *D*, which were drawn from data at many temperatures.

total heat loss does not vary appreciably within the comfort zone (see Fig. 6). Above or below this range the variation is approximately a function of effective temperature. Sensible and latent heat losses (Figs. 7 and 9) on the other hand, vary greatly within the comfort zone, the variation following closely the dry-bulb temperature.

Although total heat loss and sensible and latent heat losses are not exact functions of effective and dry-bulb temperature, respectively, for all

[36]Thermal Exchanges Between the Bodies of Men Working and the Atmospheric Environment, by F. C. Houghten, W. W. Teague, W. E. Miller, and W. P. Yant (*American Journal of Hygiene*, Vol. XIII, No. 2, March, 1931, pp. 415-431).