# ASSESSMENT OF THERMAL STRESS - THE ESSENTIALS

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The main reason for assessing thermal stress (hot or cold) in a workplace is to diagnose its causes and severity, and to provide guidance for the administrative and engineering changes that may be required to alleviate it. It is widely believed that this is a difficult, expensive, and time-consuming task. The aim of this paper is to show that, on the contrary, it can be done quickly and easily, by a single observer using simple and inexpensive instruments. The procedures described below are ones that my colleagues and I have found reliable in research projects and industry consultancies for more than 40 years. *Procedures*: We measure the thermal environment in the workplace (e.g. in a factory or a mine), and also in an adjacent shaded place outdoors to assess the prevailing weather. Three instruments suffice, namely (1) a sling (or Assmann) psychrometer; (2) an anemometer, preferably a non-directional thermo-anemometer; and (3) a globe thermometer - copper, matte black, and 15 cm in diameter. A fourth instrument, the natural wet-bulb thermometer, permits calculation of the Wet-bulb Globe Thermometer (WBGT) index of heat stress. (For a preliminary 'walk through' survey to detect sites requiring a more complete evaluation, the sling psychrometer is all that we need. Psychrometric measurements indoors and outdoors show to what extent air temperature (Ta) and water-vapour pressure (VP) in the workplace differ from those of the prevailing weather, while qualitative estimates of air velocity (AV) and radiant heat are provided by one of the most sensitive instruments available - the observer's face.) *Uses of the measurements*: From the above measurements, together with descriptions of the workers' clothing and activity, we can derive a great deal of useful information. First, we calculate VP and mean radiant temperature (MRT), thus completing our knowledge of the four primary quantities Ta, MRT, VP and AV. These provide an immediate impression of the level of thermal stress, and usually of its causes as well. Second, we calculate the extent to which MRT exceeds Ta in the workplace (i.e. the degree of added radiant heat - or vice versa in the cold), and the extent to which Ta, VP, and AV differ from those outdoors. All the above differences are due to the industrial process or other factors specific to the workplace, and they provide information about sources of thermal stress and the adequacy of ventilation. Moreover, by adding these differences to the outdoor values expected in different weather we can predict the likely workplace environment at such times. Third, we calculate, using the well known equations of Belding and Hatch, approximate but extremely useful estimates of the radiative, convective, metabolic, and total heat exchanges; of the extent to which the heat can be dissipated by the evaporation of sweat; and of the likely sweat rate and hence water requirements - estimates we have found to agree remarkably well with concurrent measurements of sweat rate. By repeating these estimates of heat exchange with different values of Ta, VP, etc. we can predict the likely effect in the workplace of different weather conditions, and of any engineering changes (e.g. radiation shielding or increased ventilation) that may be contemplated. Finally, we can calculate any desired index of thermal stress except those based on 'human analogue' devices such as the Botsball. *Conclusion*: By routinely measuring and evaluating the four primary quantities, and by estimating the workers' heat exchanges, we obtain a balanced and comprehensive assessment of thermal stress, and of the ways in which it might be alleviated.

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