INTERNATIONAL STANDARD

ISO 7243

Third edition
2017-08

Ergonomics of the thermal environment — Assessment of heat stress using the WBGT (wet bulb globe temperature) index

Ambiances chaudes — Estimation de la contrainte thermique de l'homme au travail, basée sur l'indice WBGT (température humide et de globe noir)

Reference number
ISO 7243:2017(E)

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 159, *Ergonomics*, Subcommittee SC 5, *Ergonomics of the physical environment*.

This third edition cancels and replaces the second edition (ISO 7243:1989), which has been technically revised and contains the following changes:

— in Annex A, for information, additional exposure limits are represented in Figure A.1, together with reference equations;

— the assessment of heat stress now includes the effects of clothing;

— the potential errors and adjustments for non-standard globe temperature sensors are described;

— a method for predicting the natural wet bulb temperature is provided.

Introduction

This International Standard provides a method for the assessment of heat stress. It is one of a series of standards intended for use in the assessment of thermal environments. These include standards for the assessment of hot, moderate and cold environments involving both the principles of assessment and their practical application.

The wet bulb globe temperature (WBGT) is a heat stress index and its value represents the thermal environment to which an individual is exposed. This index is easy to determine in most environments. It should be regarded as a screening method to establish the presence or absence of heat stress.

A method of estimating the thermal stress, based on an analysis of the heat exchange between a person and the environment, allows a more accurate estimation of stress and an analysis of the methods of protection (see ISO 7933). Such a method should be used either directly when it is desired to carry out an intensive analysis of working conditions in heat, or in addition to the method presented in this standard, which is based upon the WBGT index, when the WBGT values obtained exceed the reference values shown.

Ergonomics of the thermal environment — Assessment of heat stress using the WBGT (wet bulb globe temperature) index

1 Scope

This document presents a screening method for evaluating the heat stress to which a person is exposed and for establishing the presence or absence of heat stress.

It applies to the evaluation of the effect of heat on a person during his or her total exposure over the working day (up to 8 h).

It does not apply for very short exposures to heat.

It applies to the assessment of indoor and outdoor occupational environments as well as to other types of environment, and to male and female adults who are fit for work.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 7933, *Ergonomics of the thermal environment — Analytical determination and interpretation of heat stress using calculation of the predicted heat strain*

ISO 13731, *Ergonomics of the thermal environment — Vocabulary and symbols*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13731 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at http://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
wet bulb globe temperature
WBGT
simple index of the environment that is considered along with metabolic rate to assess the potential for heat stress among those exposed to hot conditions

Note 1 to entry: The WBGT combines the measurement of two derived parameters: natural wet-bulb temperature (t_{nw}) and black globe temperature (t_g). Where the sensors are influenced by direct incident radiation from the sun (solar load), either outdoors or indoors, the weighting of the globe temperature is reduced by including air temperature (t_a).

3.2
effective wet bulb globe temperature
effective WBGT
$WBGT_{eff}$
WBGT value adjusted for the effects of clothing

Note 1 to entry: It gives the WBGT environment when the actual clothing worn is equivalent to that when standard work clothing is worn (thermal insulation index I_{cl} = 0,6 clo, i_m = 0,38). See ISO 9920.

3.3
clothing adjustment value
CAV
adjustment to the WBGT value to account for the effects of clothing that has different thermal properties from that of standard work clothing

4 Method

The degree of heat stress to which a person is exposed depends on

a) the characteristics of the environment governing heat transfer between the ambient environment and the body,

b) the production of heat inside the body as a result of physical activity, and

c) the clothing worn, which modifies the exchange of heat with the environment.

A detailed analysis of the influence of the environment on heat stress requires knowledge of the following four basic parameters: air temperature, mean radiant temperature, air velocity, and absolute humidity (ISO 7726). However, an estimation of this influence can be made by measuring parameters derived from these basic parameters and which are a function of the physical parameters of the environment investigated. The WBGT index is used to give a first approximation of the heat stress on a person (see Clause 5).

The internal thermal load is the result of metabolic energy caused by activity. The rate of metabolic heat production is usually estimated (see Clause 6).

The heat stress threshold assumes a long sleeve cotton shirt and cotton trousers/pants. An adjustment shall be made for other clothing (see Clause 7).

This method for estimating heat stress is based on the assessment of these different parameters and the calculation of mean values taking into account changes in location, duration and activity, as well as variations in time (see Clause 8).

The WBGT reference values (exposure limits) presented correspond to levels of sustained exposure for up to 8 h.

The WBGT values obtained using the method are compared with WBGT reference values (exposure limits). If the values are greater than the reference values, then the risk of heat-related disorders increases and it will be necessary to either

— reduce directly the heat stress or strain at the workplace by appropriate methods, or

— carry out a detailed analysis of the heat stress using ISO 7933.

It should be noted that the exposure thresholds described in this document are designed to reduce the risk of heat-related illness and that this does not preclude the possibility of other outcomes associated with heat stress exposures (e.g. risk of burns and accidents, loss of productivity, or lack of comfort).