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Ergonomics of the thermal environment — Evaluation of thermal environments in vehicles —

Part 2: Determination of equivalent temperature

Ergonomie des ambiances thermiques — Évaluation des ambiances thermiques dans les véhicules —

Partie 2: Détermination de la température équivalente

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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 document 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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This document was prepared by Technical Committee ISO/TC 159, *Ergonomics*, Subcommittee SC 5, *Ergonomics of the physical environment*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 122, *Ergonomics,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 14505-2:2006/Cor 1:2007), which has been technically revised.

The main change is as follows:

— addition of an evaluation method for the contact areas (equivalent contact temperature).

A list of all parts in the ISO 14505 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

The interaction of convective, radiative and conductive heat exchange in a vehicle compartment is very complex. External thermal loads in combination with the internal heating and ventilation system of the vehicle create a local climate that can vary considerably in space and time. Asymmetric thermal conditions arise, and these are often the main cause of complaints of thermal discomfort. In vehicles without or with poor heating, ventilating and air-conditioning system (HVAC-system), thermal stress is determined largely by the impact of the ambient climatic conditions on the vehicle compartment.

Subjective evaluation is integrative, as the individual combines into one reaction the combined effect of several thermal stimuli. However, it is not sufficiently detailed or accurate for repeated use. Technical measurements provide detailed and accurate information but must be integrated in order to predict the thermal effects on humans. Since several climatic factors play a role for the final heat exchange of a person, these factors must be integrated to a measure, representing their relative importance.

This document includes the equivalent temperature models t_{eq} for the assessment of the thermal conditions. For special consideration of the seat, the equivalent contact temperature $t_{eq,cont}$ can be applied for body compartments in contact to surfaces. Methods for the calculation of t_{eq} using thermal factors are described in ISO 14505-4. The methodology described in this document can also be used in specific performance standards for testing of HVAC-systems for vehicles and similar confined spaces.

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Ergonomics of the thermal environment — Evaluation of thermal environments in vehicles —

Part 2: Determination of equivalent temperature

1 Scope

This document specifies requirements and recommendations for the assessment of the thermal conditions inside a vehicle compartment. It can also be applied to other confined spaces with asymmetric climatic conditions.

It applies to the assessment of thermal conditions, when deviations from thermal neutrality are relatively small.

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 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 terminology databases for use in standardization at the following addresses:

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

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

3.1
equivalent temperature
t_{eq}
temperature of a standard homogenous space, in which a person exchanges the same heat loss by convection and radiation as in the actual conditions under assessment

Note 1 to entry: The standard homogenous space is defined as an environment in which the mean radiant temperature is equal to the air temperature and there is zero air velocity.

3.2
whole body equivalent temperature
$t_{eq,whole}$
temperature of an imaginary enclosure with the same temperature in air and on surrounding surfaces and with air velocity equal to zero in which a full-scale, human shaped, heated sensor will exchange the same dry heat by radiation and convection as in the actual non-uniform environment

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3.3
segmental equivalent temperature
$t_{eq,segment}$
uniform temperature of an imaginary enclosure with the same temperature in air and on surrounding surfaces and with air velocity equal to zero in which one or more selected zones of a thermal manikin will exchange the same dry heat by radiation and convection as in the actual non-uniform environment

3.4
directional equivalent temperature
$t_{eq,direct}$
uniform temperature of an imaginary enclosure with the same temperature in air and on surrounding surfaces and with air velocity equal to zero in which a small flat heated surface will exchange the same dry heat by radiation and convection as in the actual non-uniform environment

3.5
omnidirectional equivalent temperature
$t_{eq,omni}$
uniform temperature of an imaginary enclosure with the same temperature in air and on surrounding surfaces and with air velocity equal to zero in which a heated ellipsoid will exchange the same dry heat by radiation and convection as in the actual non-uniform environment

3.6
equivalent contact temperature
$t_{eq,cont}$
uniform temperature of an imaginary contact surface in a standard homogeneous space, at which a person will exchange the same amount of dry heat through thermal conduction for a virtual clothing insulation as in the actual non-uniform environment

Note 1 to entry: The standard homogenous space is defined as an environment in which the mean radiant temperature is equal to the air temperature and there is zero air velocity. In the actual non-uniform environment, the person experiences sensible and latent heat transfer at the considered body parts.

3.7
segment
part of a human-shaped sensor, normally corresponding to a real body-part, consisting of one or several whole zones, for which a segmental equivalent temperature, $t_{eq,segment}$, is presented

3.8
zone
physical partition of a manikin, which is independently regulated and within which the surface temperature and heat exchange is measured

3.9
heating, ventilating and air-conditioning system
HVAC-system
devices that control the temperature, humidity, and purity of the air in an enclosed space

4 Assessment principles

4.1 General

The assessment principle is based on the measurement of the equivalent temperature. The equivalent temperature provides a unified, physical measure of the climatic effects on the human dry heat exchange. On the basis of the actual value for, and the variation in, equivalent temperature, it is possible to predict the conditions for heat balance under conditions in or close to the thermoneutral zone. People's thermal sensation is primarily influenced by general and local levels and variations in skin surface heat flux. Values for the equivalent temperature of a specified environment have been found to be closely related to how people perceive thermal conditions when exposed to the same environment.[12] This can be used for the interpretation of the t_{eq} value and assessment of the quality of the environment.

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