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

Part 4: Determination of the equivalent temperature by means of a numerical manikin

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

Partie 4: Détermination de la température équivalente à l'aide d'un mannequin numérique

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of 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 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*.

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, radiant and conductive heat exchange in a vehicle compartment or similar confined space is highly complex. External thermal loads in combination with the air conditioning system in a vehicle compartment create non-uniform thermal environments, which are often the main cause of complaints of thermal discomfort. In vehicles with poor or non-existent air conditioning systems, non-uniform thermal environments can also be created by the interaction between the ambient climatic conditions and vehicle structures. While a subjective evaluation reflects the total sensations of a human body, these often incur great costs while the study phase is being conducted. Physical measurements provide detailed and accurate local information; however, these results must be integrated in some way to predict the thermal effects on humans. Furthermore, since specific climatic factors sometimes play a dominant role in the overall heat exchange of a human body, an evaluation method that accounts for the relative importance of these factors is required.

This document is part of the ISO 14505 series. To meet the above-stated requirements, this document provides calculation methods that utilize numerical simulations to assess the total thermal environment of vehicles. The equivalent temperature, obtained from measurements taken using a thermal manikin, is defined in ISO 14505-2. This document extends the definition of the ISO 14505 series to include numerical evaluation when this document is used in conjunction with the equivalent temperature defined in ISO 14505-2.

As described in ISO 14505-2, an equivalent temperature can be utilized in the assessment of vehicle cabins and other various enclosed spaces with non-uniform environments. As is the case for ISO 14505-2, this document can also be applied to vehicle cabins and other enclosed spaces.

This document supposes that the ISO 14505 series will be applied to various situations, such as:

— in the case of experimental facilities that are not prepared;

— in the case of prototypes that are incomplete;

— in the case of conditions that are difficult to simulate in controlled experimental settings;

— in the case that occupants are extrapolated to unknown or virtual environments.

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

Part 4: Determination of the equivalent temperature by means of a numerical manikin

1 Scope

This document provides guidelines for extending the definition of equivalent temperature to predictive purposes and specifies a standard prediction method for the assessment of thermal comfort in vehicles using numerical calculations. Specifically, this document sets forth a simulated numerical manikin as a viable alternative to the thermal manikin for the purpose of calculating the equivalent temperature.

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*

ISO 14505-2, *Ergonomics of the thermal environment — Evaluation of thermal environments in vehicles — Part 2: Determination of equivalent temperature*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13731 and ISO 14505-2 and the following apply.

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

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

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

3.1
numerical manikin
virtual thermal manikin recreating a thermal manikin, or a digital model of a thermal manikin used to calculate performance

3.2
physical manikin
real thermal manikin to measure real environment

3.3
computational fluid dynamics
CFD
simulation of a series of calculations based on specific boundary conditions and specific parameters associated with fluid and thermal fields using discrete equations based on the Navier-Stokes/Lattice-Boltzmann equations as well as heat transfer equations that consider convection, radiation and conduction, and generally account for the effects of turbulent flow

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