TECHNICAL SPECIFICATION

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Ergonomics of the thermal environment — Methods for the assessment of human responses to contact with surfaces —

Part 2: Human contact with surfaces at moderate temperature

Ergonomie des ambiances thermiques — Méthodes d'évaluation de la réponse humaine au contact avec des surfaces —

Partie 2: Contact humain avec des surfaces à température modérée

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.ch
Web www.iso.ch

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

In other circumstances, particularly when there is an urgent market requirement for such documents, a technical committee may decide to publish other types of normative document:

— an ISO Publicly Available Specification (ISO/PAS) represents an agreement between technical experts in an ISO working group and is accepted for publication if it is approved by more than 50 % of the members of the parent committee casting a vote;

— an ISO Technical Specification (ISO/TS) represents an agreement between the members of a technical committee and is accepted for publication if it is approved by 2/3 of the members of the committee casting a vote.

An ISO/PAS or ISO/TS is reviewed every three years with a view to deciding whether it can be transformed into an International Standard.

Attention is drawn to the possibility that some of the elements of this part of ISO/TS 13732 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TS 13732-2 was prepared by Technical Committee ISO/TC 159, *Ergonomics*, Subcommittee SC 5, *Ergonomics of the physical environment*.

ISO/TS 13732 consists of the following parts, under the general title *Ergonomics of the thermal environment — Methods for the assessment of human responses to contact with surfaces*:

— *Part 1: Human contact with hot surfaces*

— *Part 2: Human contact with surfaces at moderate temperature*

Introduction

Contact between bare skin and solid surfaces may cause thermal discomfort depending upon the part of the body in contact, the temperature of the material and the type of material. It may also increase the risk when handling machines, hand tools and in the home. Bare skin in contact with metal at room temperatures may cause a cold sensation, while contact with wood may feel comfortable. The sensation and discomfort felt should be taken into account when designing and constructing handrails, handles of vehicles, hand tools, floor materials in spaces where people walk with bare feet and children play on the floor. In this part of ISO/TS 13732, some fundamental ergonomic data are presented to help the prediction of thermal sensation and discomfort caused by contact with surfaces in the moderate temperature range.

Ergonomics of the thermal environment — Methods for the assessment of human responses to contact with surfaces —

Part 2:
Human contact with surfaces at moderate temperature

1 Scope

This part of ISO/TS 13732 presents principles and methods for predicting the thermal sensation and degree of discomfort for people where parts of the body are in contact with solid surfaces at moderate surface temperatures (approximately 10 °C to 40 °C).

It deals with the thermal sensation for contacts of the hand, foot and for the sitting position on the floor.

2 Normative reference

The following normative document contains provisions which, through reference in this text, constitute provisions of this part of ISO/TS 13732. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO/TS 13732 are encouraged to investigate the possibility of applying the most recent edition of the normative document indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

EN 563, *Safety of machinery — Temperatures of touchable surfaces — Ergonomics data to establish temperature limit values for hot surfaces.*

3 Parameters which influence the thermal sensation by contact

It is important to take 3.1 to 3.5 into account when predicting the thermal sensation.

3.1 Skin temperature and environmental temperature

In a warm environment, a cool surface may feel comfortable; conversely, in a cool environment a warm surface may feel comfortable. Thus, the thermal sensation on making contact with a surface is influenced by the ambient temperature. The same surface may feel cool or warm depending on the temperature of the body part making contact. So, the ambient temperature and skin temperature will both influence the thermal sensation.

3.2 Body part and type of object in contact

The surface temperature for comfort depends on the type of object (floor, handle), the body part (hand, foot) and the surface material (metal, wood). The body part in contact with the object and surface material shall be known in order to predict the thermal sensation.

3.3 Contact duration and contact pressure

The temperature of the skin in contact with a surface may change with the duration of the contact and, consequently, the thermal sensation may change with time. The duration of contact shall therefore be determined to predict the thermal sensation. For example, the duration of contact between the foot and the floor in a living room may be for more than 10 min when standing or for less than 1 min when walking; contact between the hand and a door knob may be for only a few seconds. The temperature of the skin, when in contact under high pressure, is higher in the case of a warmer surface and lower in the case of a cooler surface, than for a low contact pressure, due to the restricted circulation of blood in the capillary vessels. In the case of a high contact pressure of a long duration of contact in moderate temperature conditions, local discomfort, and even tissue damage, may be caused at temperatures below the pain threshold (see EN 563).

3.4 Surfaces with or without a heat source

There are three typical cases:

— a surface without a heat source, when the surface temperature is close to the ambient temperature (handle, handrail, hand tool, furniture);

— a surface with heating to obtain a comfortable surface temperature higher than the ambient temperature (floor heating, seat heating);

— a surface with a cooling source to obtain a surface temperature lower than the ambient temperature (floor cooling, ice-bag).

The surface temperature and the type of heat supply to the surface are important factors for the prediction of thermal sensation. It should be noted that a basic difference exists between electrical heating and water-based heating. In the case of electrical heating, a certain heat input is provided independently of the surface temperature. A water-based heating system will not produce temperatures higher than the water temperature.

3.5 Contact coefficient and thermal diffusivity

The thermal sensation by contact depends on the surface materials, even if the materials are at the same temperature. The contact temperature, t_k, which results from the contact between two solid objects at different temperatures, can be calculated as:

$$t_k = (b_1 \cdot t_1 + b_2 \cdot t_2) / (b_1 + b_2) \quad (1)$$

where

t_1 is the initial temperature of object 1, in degrees Celsius;

t_2 is the initial temperature of object 2, in degrees Celsius;

b_1 is the contact coefficient of object 1, in watts hour to the power 0,5 per square metre degree Celsius;

b_2 is the contact coefficient object 2, in watts hour to the power 0,5 per square metre degree Celsius.

The contact coefficient is calculated as

$$b = \left(\lambda \cdot c \cdot \rho\right)^{0,5} \quad (2)$$

where

λ is the thermal conductivity, in watts per metre degree Celsius;

c is the specific heat, in joules per kilogram degree Celsius;

ρ is the specific mass, in kilograms per cubic metre.