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

Part 1: Hot surfaces

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

Partie 1: Surfaces chaudes

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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.org
Web www.iso.org

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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 2.

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.

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.

ISO 13732-1 was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 122, *Ergonomics*, in collaboration with Technical Committee ISO/TC 159, *Ergonomics*, Subcommittee SC 5, *Ergonomics of the physical environment*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

ISO 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: Hot surfaces*

— *Part 2: Human contact with surfaces at moderate temperature* [Technical Specification]

— *Part 3: Cold surfaces*

Introduction

When human skin comes into contact with a hot solid surface, burns may occur. Whether or not they do depends on a number of factors, the most important of which are

— the temperature of the surface,

— the material of the surface,

— the period of contact between the skin and the surface,

— the structure of the surface, and

— the sensitivity of the human being who comes into contact with the surface (e.g. child or adult).

Other factors can also play a part but are of minor importance. In Annex A the scientific background is presented and in the Bibliography publications concerning the objective are listed.

This part of ISO 13732 contains a collection of temperature threshold values for burns when the skin is in contact with a hot solid surface (Clause 4). It also contains a method for the assessment of the risk of burning, i.e. the application of the provided ergonomics data within a risk assessment procedure (Clause 5). A further application of the data may be the specification of temperature limit values for hot surfaces. Such temperature limit values may be specified in product standards or in regulations in order to prevent human beings sustaining a burn when in contact with the surface of a hot product. Guidance on how to select reasonable temperature limit values for that purpose is given in Clause 7. For different products with the same risk of burning it is reasonable to establish identical surface temperature limit values. Therefore, this part of ISO 13732 provides the possibility of harmonizing such temperature limit values for all kind of products.

Touching a hot surface may take place intentionally, e.g. to operate an electrically or gas powered machine or tool, or unintentionally, when a person is near a hot object. The period of contact with the hot surface will be different if the object is touched intentionally than if it is touched unintentionally. Considering human reaction times and their distribution in the population, 0,5 s is the minimum applicable contact period for unintentional touching of a hot surface for healthy adults on an acceptable safety level. For intentional touching the minimum applicable contact period will be longer. For the application of this part of ISO 13732, it is essential to select a contact period which best represents the real circumstances when a hot product is touched. Guidance for such selection is given in Annex B.

The ergonomics data provided in this part of ISO 13732 are mainly based on scientific research and represent, as far as is known, the behaviour of the human skin when in contact with a hot surface. Some of the data (e.g. burn threshold data for very short contacts of 0,5 s) are not directly based on scientific research but are deduced by extrapolation of the known threshold curves or by reasonable conclusion using scientific results.

The temperature threshold values provided in this part of ISO 13732 are valid for burning the skin when in contact with hot surfaces. For the time being there are not sufficient scientific data available on the effects of discomfort and pain to for them to be included in this part of ISO 13732. Some data for pain can be derived from national standards (see Annexes A and the Bibliography). Research projects are planned for obtaining data for discomfort and pain. When the results of these projects are available, this part of ISO 13732 may be revised in order to also include discomfort and pain temperature threshold values. ISO 13732-2 deals also with discomfort.

This part of ISO 13732 does not provide burn data on the skin that comes into contact with liquids or gases.

NOTE With the exception of water there are no such data available up to now. For water and liquids with similar heat capacity and heat flow properties burn threshold values for bare metals can be chosen.

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

Part 1: Hot surfaces

1 Scope

This part of ISO 13732 provides temperature threshold values for burns that occur when human skin is in contact with a hot solid surface.

It also describes methods for the assessment of the risks of burning, when humans could or might touch hot surfaces with their unprotected skin.

This part of ISO 13732 also gives guidance for cases where it is necessary to specify temperature limit values for hot surfaces; it does not set surface temperature limit values.

NOTE 1 Such temperature limit values can be specified in specific product standards or in regulations in order to prevent human beings sustaining burns when in contact with the hot surface of a product.

This part of ISO 13732 deals with contact periods of 0,5 s and longer.

It is applicable to contact when the surface temperature is essentially maintained during the contact (see 4.1).

It is not applicable if a large area of the skin (approximately 10 % or more of the skin of the whole body) can be in contact with the hot surface. Neither does it apply to skin contact of more than 10 % of the head or contact which could result in burns of vital areas of the face.

NOTE 2 In some cases, the results of contact with a hot surface can be more serious for the individual, for example:

— burns resulting in the restriction of airways;

— large burns (more than 10 % of the body surface) that can impair the circulation by fluid loss;

— heating of a large proportion of the head or whole body that could lead to unacceptable heat strain even in the absence of burning.

This part of ISO 13732 is applicable to the hot surfaces of all kind of objects: equipment, products, buildings, natural objects, etc. For the purposes of simplification, it mentions only products; nevertheless, it applies to all other objects as well.

It is applicable to products used in any environment, e.g. in the workplace, in the home.

It is applicable to hot surfaces of products that may be touched by healthy adults, children, elderly people and also by people with physical disabilities.

It does not provide data for the protection against discomfort or pain.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments).

ISO 7726:1998, *Ergonomics of the thermal environment — Instruments for measuring physical quantities*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
touchable surface
surface of a product that can be touched by a person's skin

3.2
surface temperature
T_s
temperature of a material's surface

NOTE Surface temperature is expressed in degrees Celsius (°C).

3.3
contact period
D
duration of contact of the skin with the surface

NOTE Contact period is expressed in seconds (s).

3.4
thermal inertia
product of density (ρ), thermal conductivity (K) and specific thermal capacity (c) of a material

3.5
burn threshold
surface temperature defining the boundary between no burn and a superficial partial thickness burn, caused by contact of the skin with this surface for a specified contact period

NOTE Burns are classified into three levels, depending on severity.

— superficial partial thickness burn:

  in all but the most superficial burns, the epidermis is completely destroyed but the hair follicles and sebaceous glands as well as the sweat glands are spared.

— deep partial thickness burn:

  a substantial part of the dermis and all sebaceous glands are destroyed and only the deeper parts of the hair follicles or the sweat glands survive.

— whole thickness burn:

  the full thickness of the skin is destroyed and there are no surviving epithelial elements.

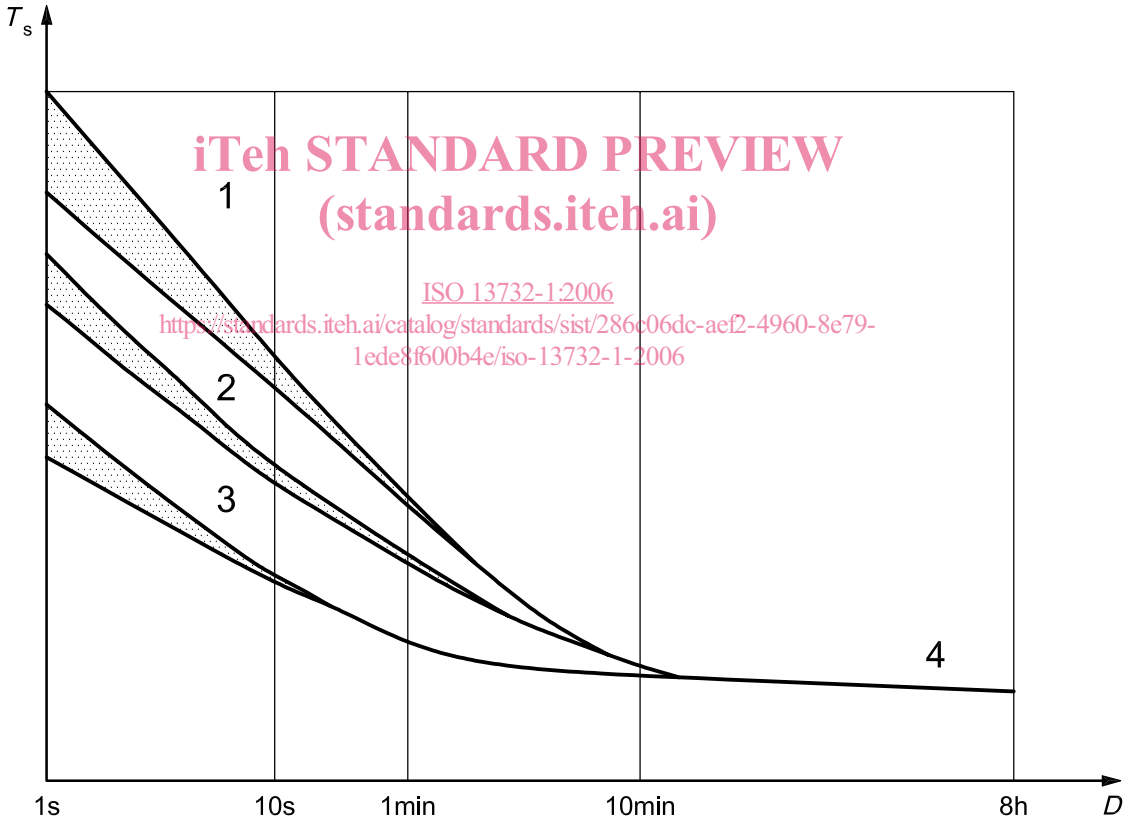
4 Burn thresholds

4.1 General

This clause provides surface temperature data for burn thresholds.

NOTE The occurrence of burning depends on the temperature of the skin and on the period of raised skin temperature. The connection between skin temperature, the period of its influence and occurrence of burning has been scientifically studied and is known (see Annex A). But it is not practicable by simple means to measure the temperature of the skin during its contact with the hot surface of a product. Therefore, in this part of ISO 13732 it is not the temperature values of the skin which are specified but the temperature values of hot surfaces of products which, when in contact with the skin, lead to burns (the burn thresholds). The temperature of a surface of a product is simply measurable by appropriate measuring facilities.

The surface temperatures which lead to burns during contact of the skin with a hot product depend on the material of which the product consists, and on the period of the contact of the skin with the surface. This relationship is presented in Figure 1, which shows this relationship for several groups of materials which have similar heat conductivity properties and therefore similar burn thresholds.



Key

D contact period
T_s surface temperature
1 plastics
2 ceramics
3 metals
4 burn threshold

Figure 1 — Illustration of general relationship between burn threshold and contact period when hot surface is touched by skin

A point on a burn threshold curve indicates, for a particular contact period, that surface temperature which lies between non-injury of the skin and the onset of a superficial partial thickness burn when the skin comes into contact with the hot surface. Surface temperature values lying below the curve in general do not lead to a burn. Surface temperature values lying above the curve will lead to a burn of the skin (see also Annex A).

The illustrative Figure 1 only serves to provide a better understanding and does not accurately represent the burn threshold data. The exact burn threshold values are to be taken from Figures 2, 5, 6 and 7 and Table 1.

For short contact periods the burn thresholds are not drawn as lines in the illustrative Figure 1 and the detailed Figures 2, 5, 6 and 7, but as spreads. This takes into account the fact that for short contact periods the knowledge of the temperature boundary between non-burning and the onset of burning is not complete. The burn threshold depends on several factors, including thickness of the skin at the touching point, moisture of the skin's surface (sweating), contamination of the skin (e.g. grease), touching force differences between the heat conductivity properties of materials which have been combined in one group, uncertainties of the scientific determination of the burn threshold values (see also Annex A). However, these influences are considered to be minor compared to the influence of the heat conductivity properties of the different material groups.

For longer contact periods the uncertainties are less than for short contact periods. So for long contact periods exact values for burn thresholds are specified. The differences in the values for different groups of materials also disappear for long contact periods.

The data given presumes that the surface temperature is essentially maintained during the contact period either by the mass of the product or by a heating source. These conditions will describe exposures which are in conformity with the worst case.

4.2 Burn threshold data

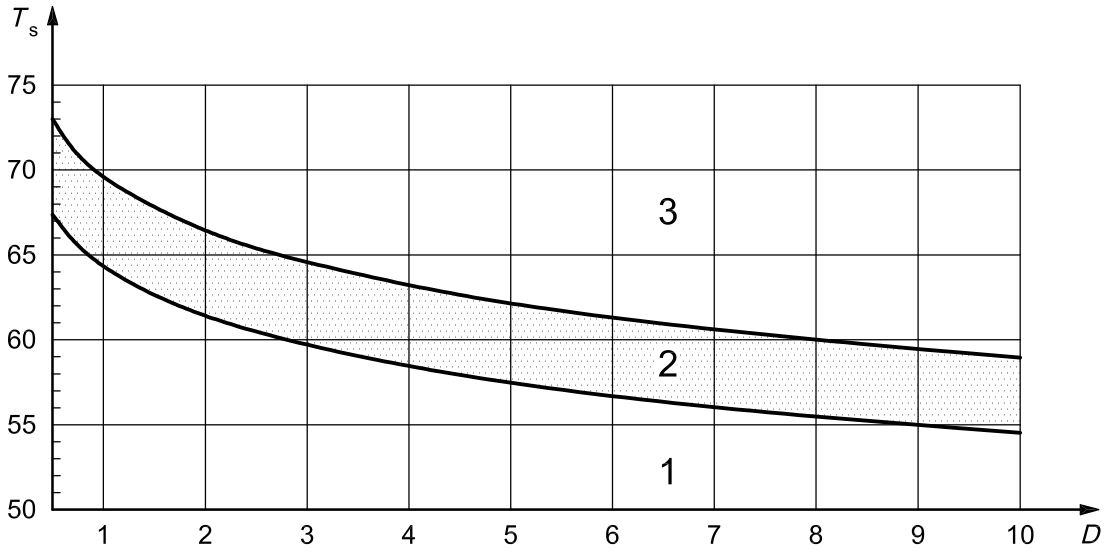
4.2.1 Burn thresholds for contact periods between 0,5 s and 10 s

4.2.1.1 General

In the case of short contact (contact periods of 0,5 s to 10 s), the burn threshold spreads are not set in numbers but are reflected in graphs in relation to the contact period. The burn thresholds of materials with similar heat conductivity properties are combined to represent one spread.

4.2.1.2 Uncoated metals

The burn thresholds presented in Figure 2 are valid for the smooth surfaces of uncoated metals. In the case of rough metal surfaces, however, the values may lie above those for smooth surfaces, but not more than 2 °C beyond the upper limit of the indicated burn threshold spread.



Key

D contact period, s

T_s surface temperature, °C

1 no burn

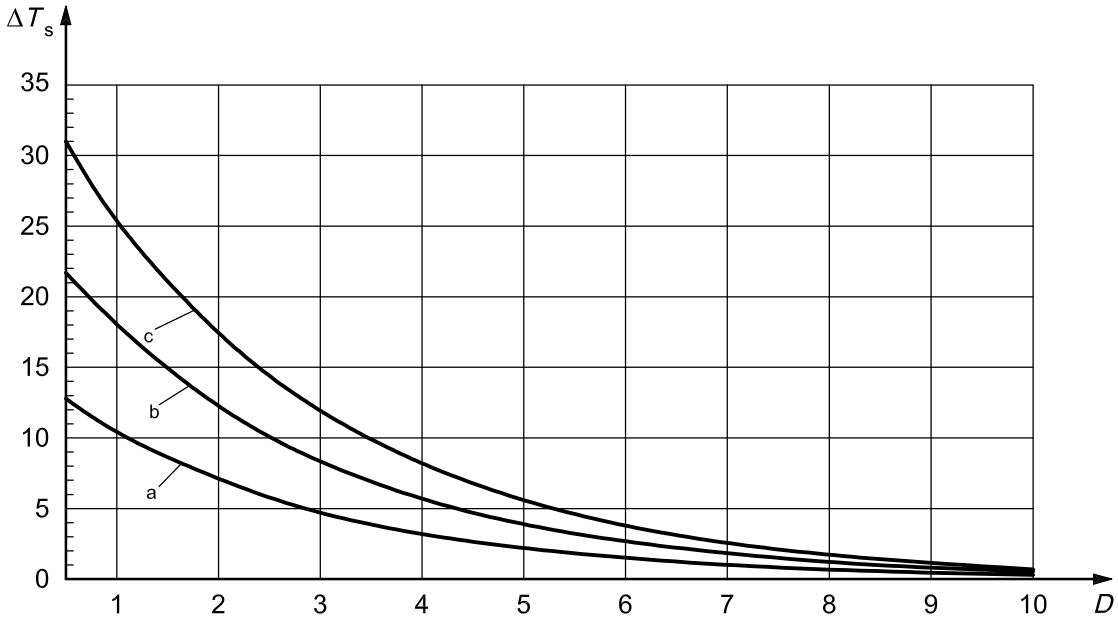
2 burn threshold

3 burn

Figure 2 — Burn threshold spread when the skin in contact with hot, smooth surface made of bare (uncoated) metal

4.2.1.3 Coated metals

The values for the effect of coating a metal are shown in Figures 3 and 4. The values reflect the rise of the burn threshold above the burn threshold for uncoated metal. In order to obtain a burn threshold for coated metal, the value for the rise of the burn threshold in Figure 3 or 4 and the burn threshold for the uncoated metal in Figure 2 have to be added.



Key

D contact period, s

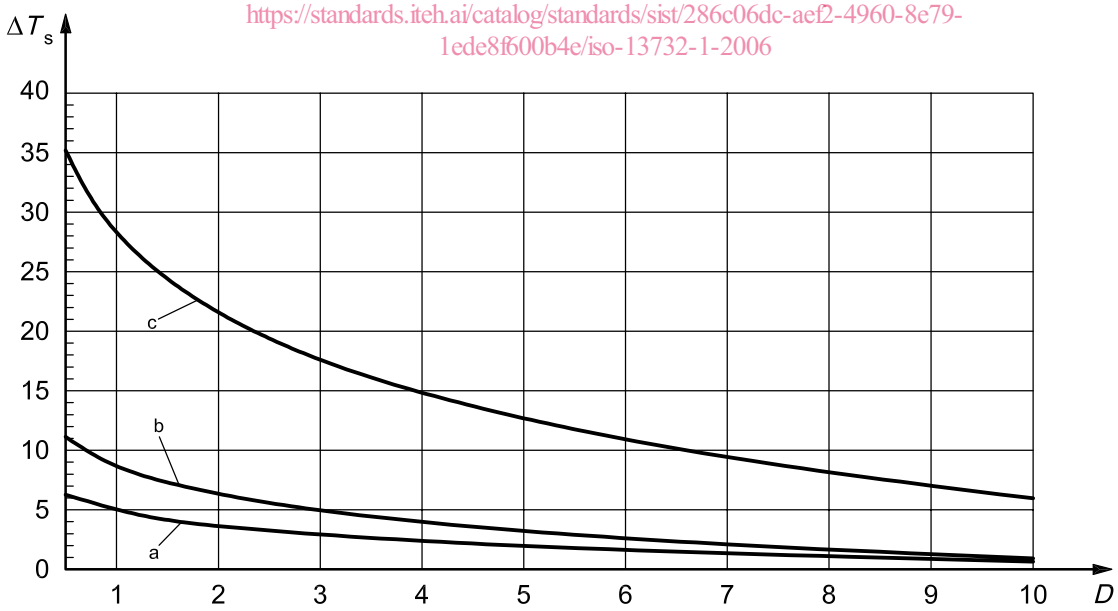
ΔT_s rise in surface temperature, °C

a 50 µm.

b 100 µm.

c 150 µm.

Figure 3 — Rise in burn threshold spread from Figure 2 for metals coated by lac of 50 µm, 100 µm and 150 µm



Key

D contact period, s

ΔT_s rise in surface temperature, °C

a Enamel (160 µm)/powder (60 µm).

b Powder (90 µm).

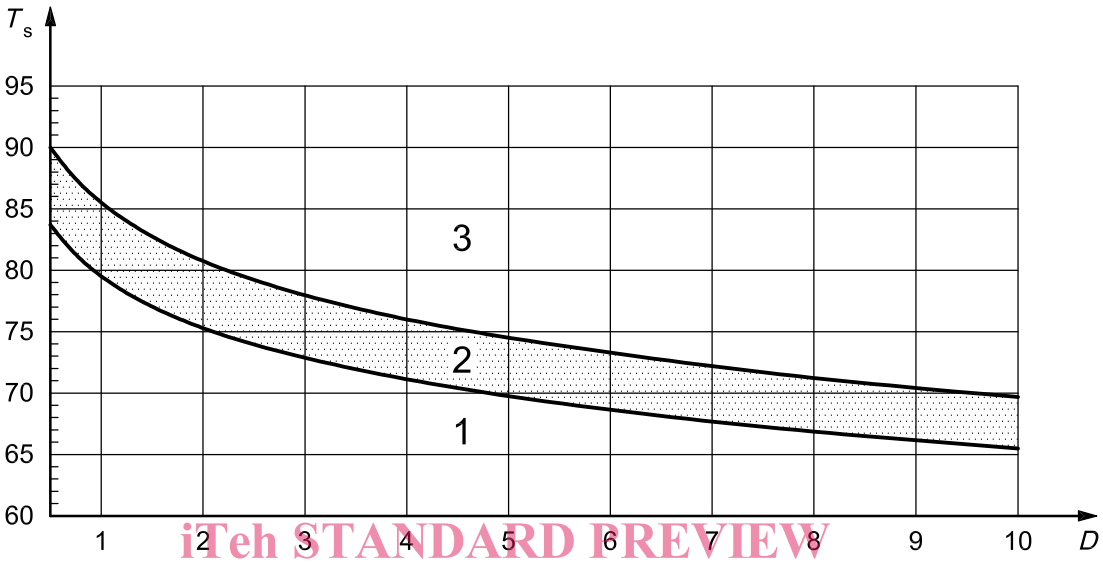
c Polyamide 11 or 12 (400 µm thickness).

Figure 4 — Rise in burn threshold spread from Figure 2 for metals coated by powder (60 µm and 90 µm), enamel (160 µm) and polyamide 11 or 12 (400 µm thickness)

4.2.1.4 Ceramics, glass and stone materials

The burn threshold spread for ceramics, glass ceramics, glass, porcelain and stone materials (marble, concrete) is shown in Figure 5.

The burn thresholds for marble and concrete lie towards the lower limit of the spread. Burn thresholds for glass lie towards the upper limit of the spread.



Key

D contact period, s

T_s surface temperature, °C

1 no burn

2 burn threshold

3 burn

Figure 5 — Burn threshold spread when skin is contact with hot, smooth surface made of ceramics, glass and stone materials

4.2.1.5 Plastics

The burn threshold spread for plastics (polyamide, acrylglass, polytetrafluorethylene, duroplastic) is shown in Figure 6.

NOTE Plastics have very different levels of thermal conductivity, depending on chemical composition. The burn threshold spread for most solid plastics is indicated in Figure 6. However, for plastics with heat conductivity properties which differ markedly from those of the materials given here, the burn thresholds indicated cannot be used. For these materials, burn thresholds have to be calculated, estimated or measured according to Annex A.