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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

ICS 13.180

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ISO/DIS 13732-1

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Foreword

This document (prEN ISO 13732-1:2004) has been prepared by Technical Committee CEN/TC 122 "Ergonomics", the secretariat of which is held by DIN, in collaboration with Technical Committee ISO/TC 159 "Ergonomics".

This document is currently submitted to the parallel Enquiry.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA which is an integral part of this document.

EN 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"¹⁾:

- Part 1: Hot surfaces;
- Part 3²⁾ : Cold surfaces.

This standard replaces the existing European standards EN 563:1994 and EN 13202:2000 completely.

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Introduction

ISO/DIS 13732-1

When human skin comes into contact with a hot solid surface, a burn may occur. Whether a burn occurs depends on several factors. The most important factors are:

- the temperature of the surface;
- the material of which the surface consists;
- the period of contact between the skin and the surface;
- the structure of the surface;
- the sensitivity of the human being who contacts (e.g. children, adults, etc.).

Other factors may 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 standard 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 to sustain a burn when in contact with the surface of an hot product. A guidance how to select reasonable temperature limit values for that purpose is given in clause 7. For different products with the same risk of

1) Part 2: has been published as ISO Technical specification ISO/TS 13732-2:2001 "Human contact with surfaces at moderate temperature"

2) This European Standard is under preparation by CEN/TC 122/WG 3 "Surface temperatures"

burning it is reasonable to establish identical surface temperature limit values. Therefore this standard provides the possibility of harmonising 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 may take place unintentionally, when a person is near to an hot object. The period of contact with the hot surface will be different if the object is touched intentionally or 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 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 standard it is essential to select a contact period which represents best the real circumstances when an hot product is touched. A guidance for this selection is given in annex B.

The ergonomics data provided in this standard are mainly based on scientific research and represent, as far as is known, the behaviour of the human skin when in contact with an 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 the scientific results.

The temperature threshold values provided in this standard are valid for burning the skin when in contact with hot surfaces. At the time being there are not sufficient scientific data available on the effects of discomfort and pain to include these data in this standard. Some data for pain can be derived from national standards (see annexes A, bibliography and PD 6504 [13]). Research projects are planned in order to get data for discomfort and pain. When the results of these projects are available this standard may be revised in order to include also discomfort and pain temperature threshold values. Part 2 of this standard deals also with discomfort.

This standard does not provide burn data when the skin 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.

1 Scope

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This standard provides temperature threshold values for the occurrence of burns when the human skin is in contact with a hot solid surface.

This standard also describes methods for the assessment of the risks of burning, when humans can or may touch hot surfaces with the unprotected skin.

This standard also gives guidance when it is necessary to specify temperature limit values for hot surfaces. This standard gives guidance but does not set surface temperature limit values.

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

This standard applies to contact periods of 0,5 s and longer.

This standard 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. This standard is also not applicable 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 may be more serious for the individual, e.g.:

- burns resulting in the restriction of airways;
- large burn (more than 10 % of the body surface) may impair the circulation by fluid loss;
- heating of a large proportion of the head or whole body may lead to unacceptable heat strain even in the absence of burning.

This standard applies to hot surfaces of all kind of objects: equipment, products, buildings, natural objects, etc. In order to simplify the standard only products are mentioned herein, but it applies to all other objects, too.

This standard applies to products used in any environment, e.g. workplaces, the home etc..

This standard applies to hot surfaces of products which may be touched by healthy adults, children, elderly people and also by people with physical disabilities.

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

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN ISO 7726:2001, *Ergonomics of the thermal environment - Instruments for measuring physical quantities*

EN 71-1:1998, *Safety of toys - Part 1: Mechanical and physical properties.*

IEC 1032, *Testing equipment and testing methods - Test probes to verify protection by enclosures.*

3 Terms and definitions

For the purposes of this standard, the following definitions apply:

3.1

touchable surface

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

[ISO/FDIS 13732-3:2003]

3.2

surface temperature

T_s

temperature of a material surface

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

[ISO/FDIS 13732-3:2003]

3.3

contact period

D

the duration during which contact of the skin with the surface takes place

NOTE Contact duration is expressed in seconds (s).

[ISO/FDIS 13732-3:2003]

3.4

thermal inertia

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

[ISO/FDIS 13732-3:2003]

3.5

burn threshold

the 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 3 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:
When the full thickness of the skin has been 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, 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 standard 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.

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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. Figure 1 shows this relationship for several groups of materials which have similar heat conductivity properties and therefore similar burn thresholds.

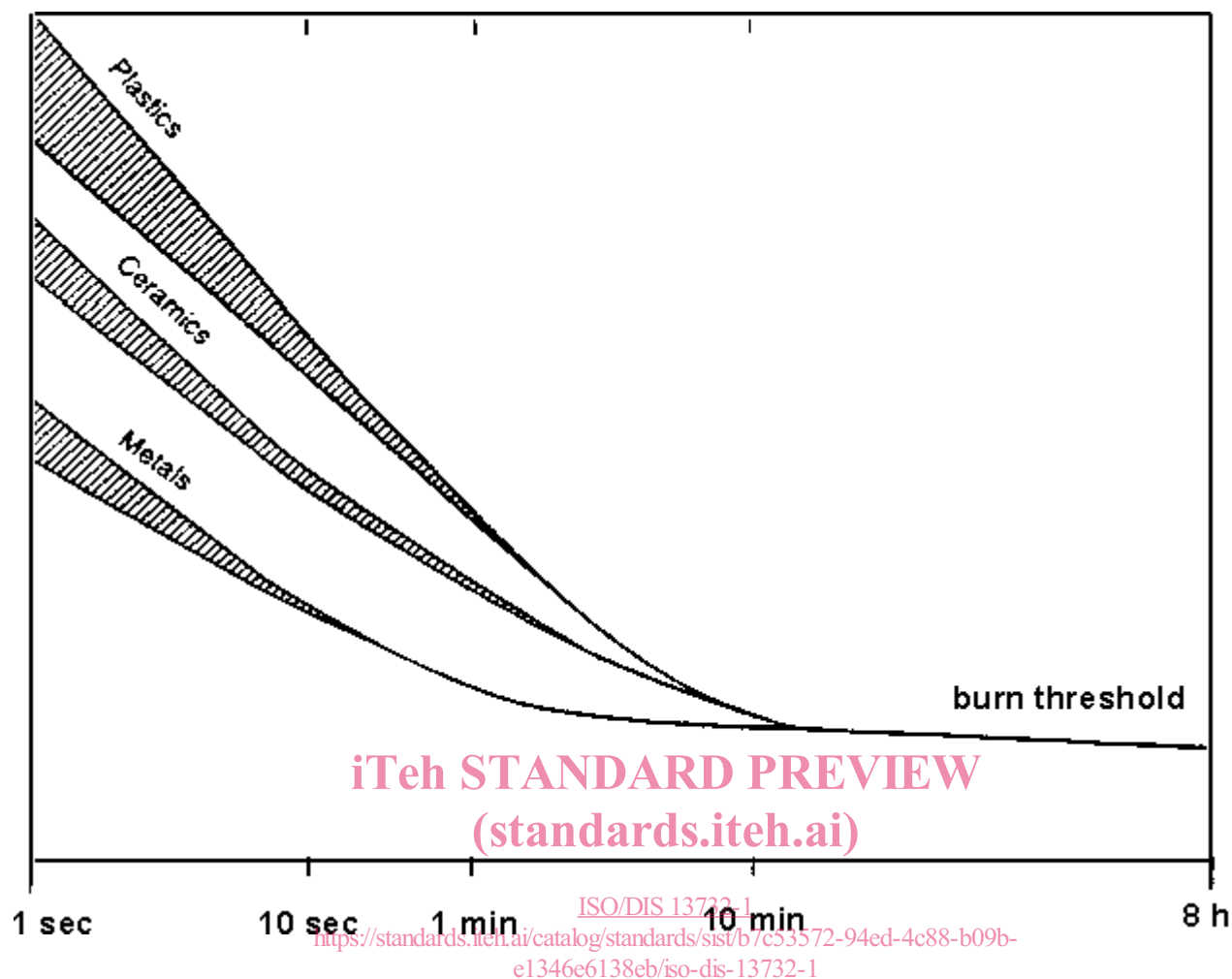


Figure 1 — Illustration of general relationship between the burn threshold and the contact period when a hot surface is touched by the skin

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 better understanding and does not accurately represent the burn threshold data. The exact burn threshold values have to be taken from Figures 2 to 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 to 6, but are drawn 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 which include: 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 small 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 in 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 and 10 seconds

4.2.1.1 General

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

4.2.1.2 Uncoated metals

The burn thresholds presented in Figure 2 are valid for 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.

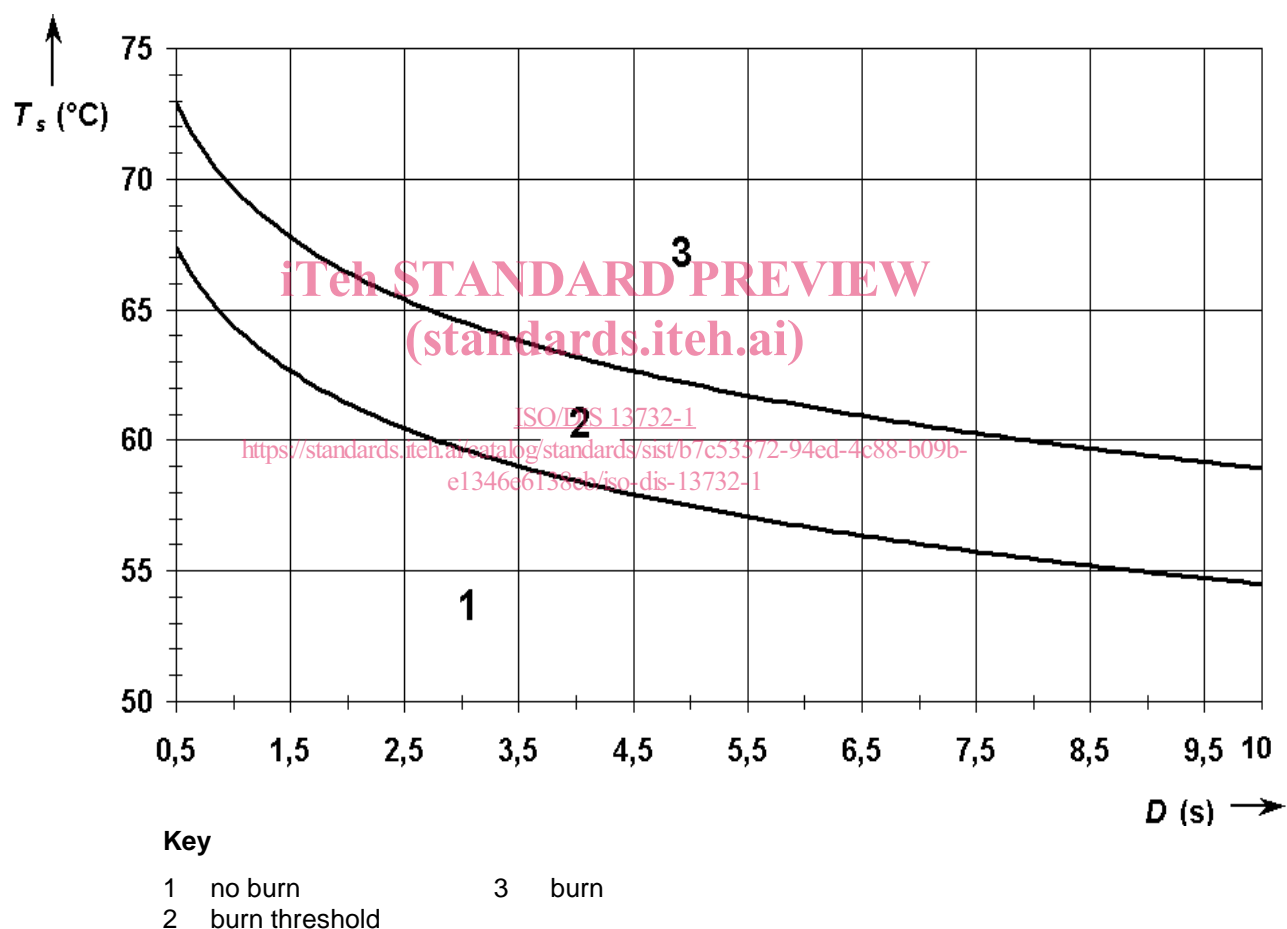


Figure 2 — Burn threshold spread when the skin is in contact with a hot smooth surface made of bare (uncoated) metal

4.2.1.3 Coated metals

The values for the effect of coating a metal are shown in Figure 3 and 4. The values reflect the rise of the burn threshold above the burn threshold for uncoated metal. 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

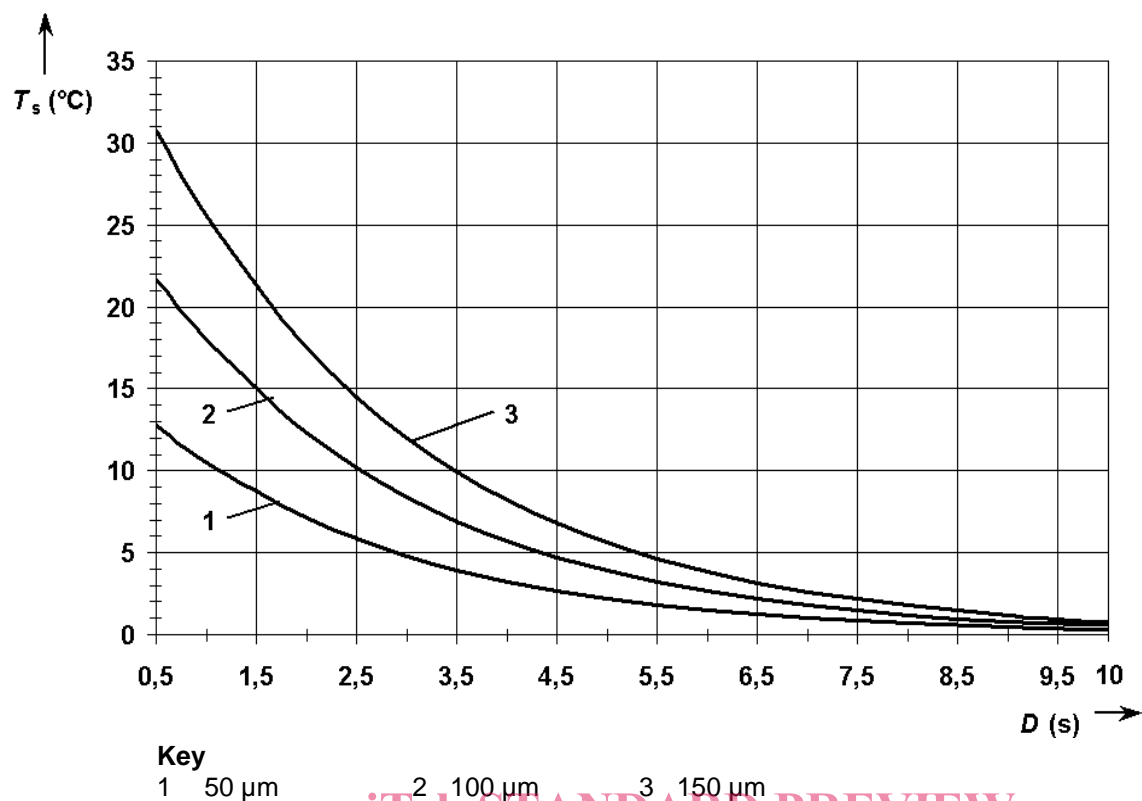


Figure 3 — Rise in the burn threshold spread from Figure 2 for metals which are coated by lac of a thickness of 50 μm, 100 μm and 150 μm

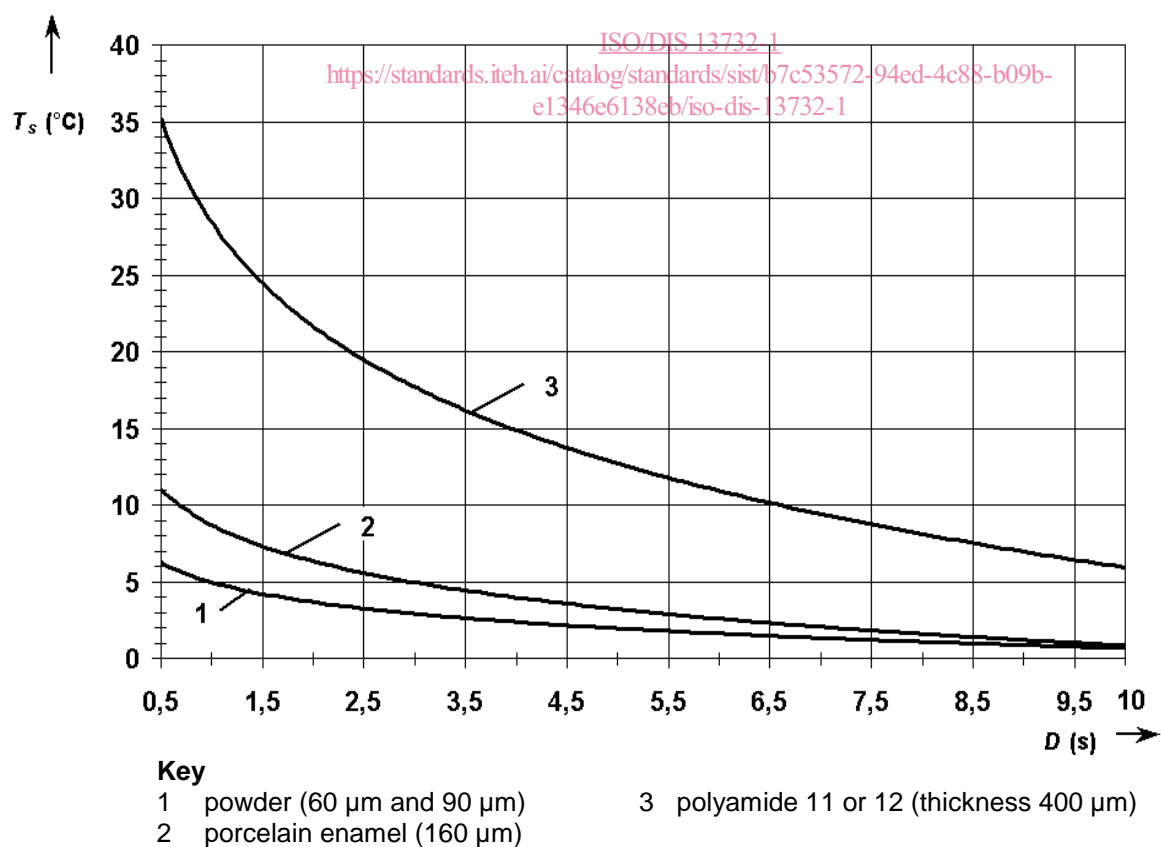


Figure 4 — Rise in the burn threshold spread from Figure 2 for metals which are coated by powder (60 μm and 90 μm), porcelain enamel (160 μm) and polyamide 11 or 12 (thickness 400 μm)

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

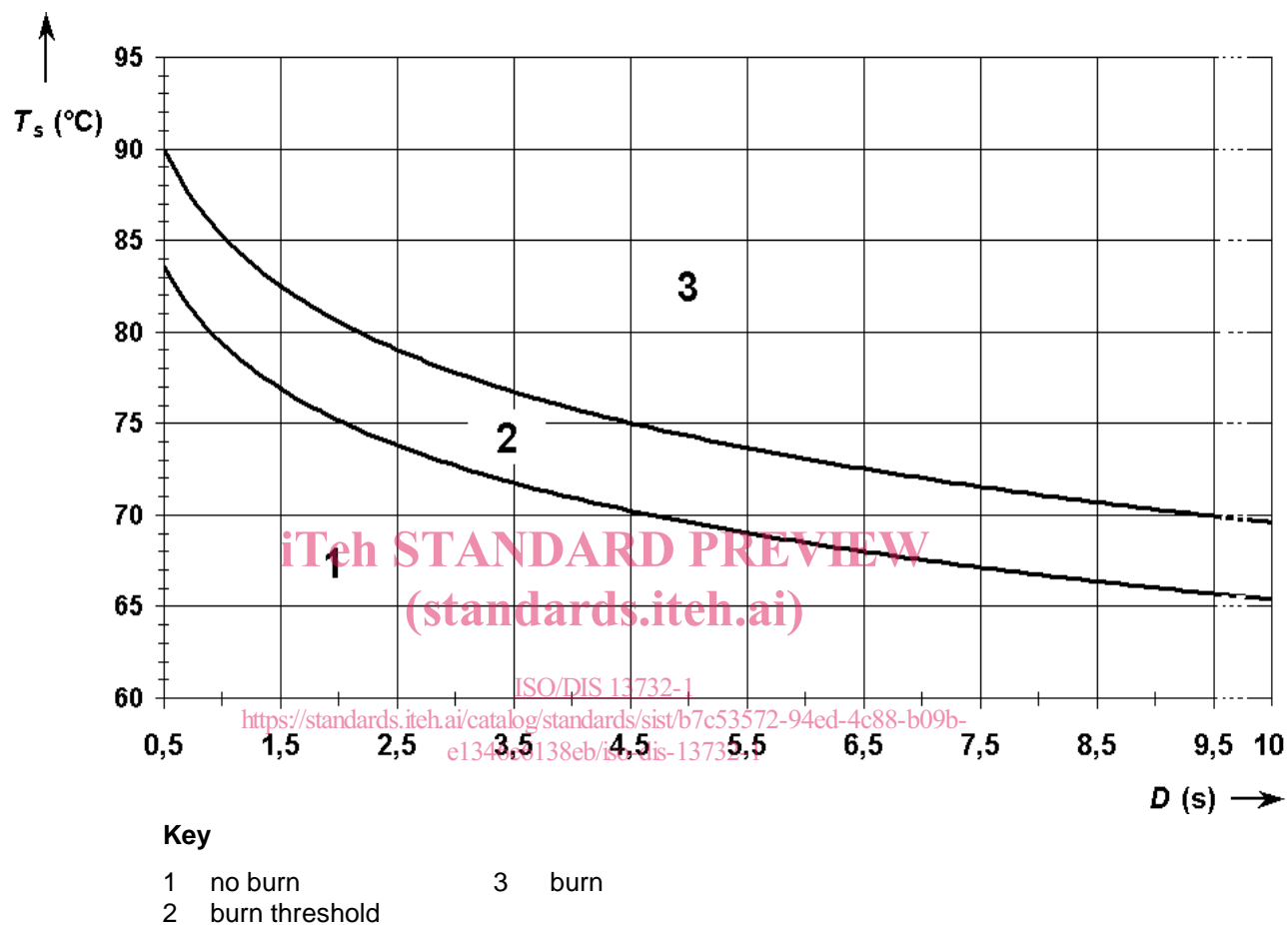


Figure 5 — Burn threshold spread when the skin is in contact with a hot smooth surface made of ceramics, glass and stone materials

4.2.1.5 Plastics

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

NOTE Plastics have very different levels of thermal conductivity, depending on the 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 in 4.2.1.5, burn thresholds as indicated in Figure 6 cannot be used. For these materials burn thresholds have to be calculated, estimated or measured as described in annex A.

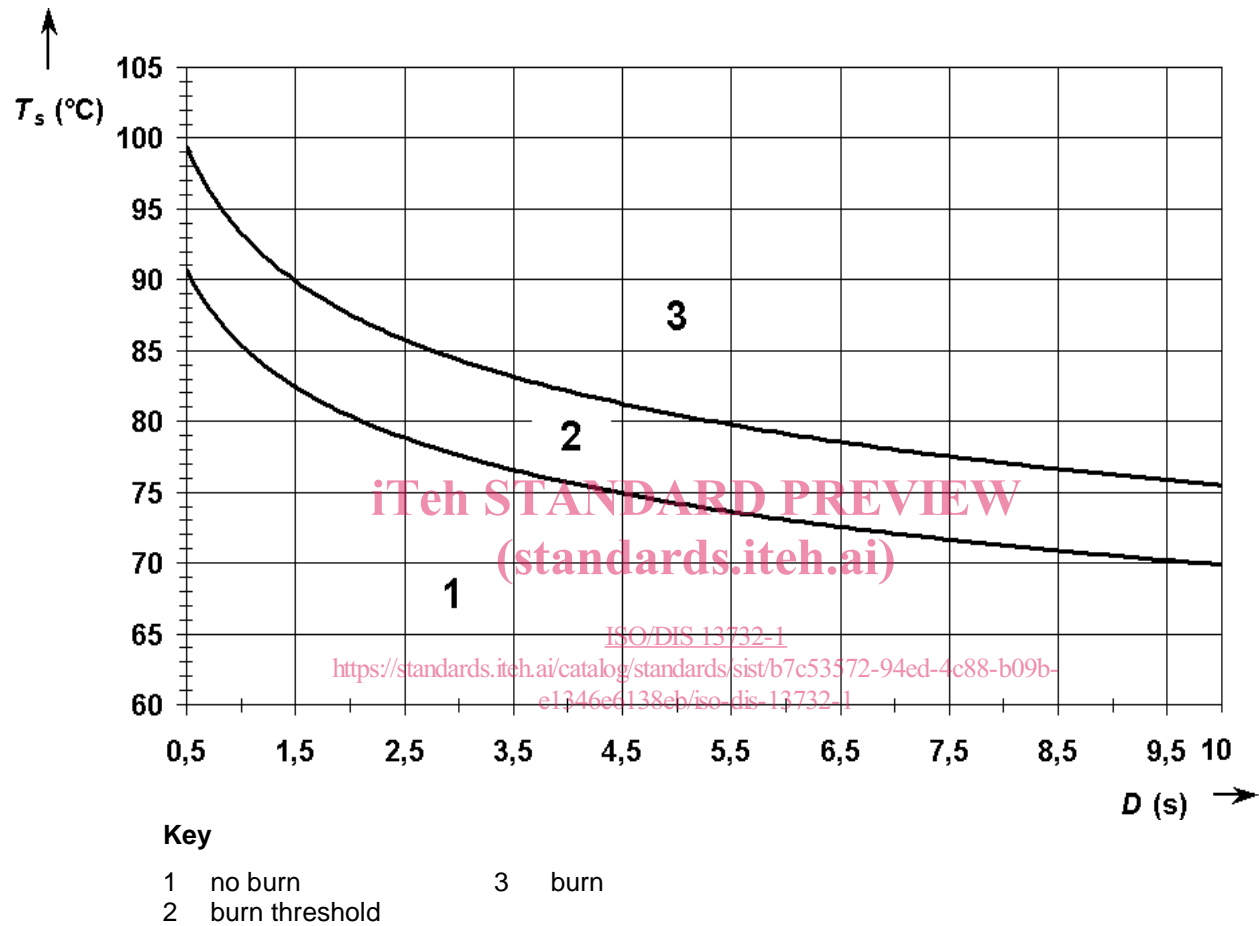


Figure 6 — Burn threshold spread when the skin is in contact with a hot smooth surface made of plastics