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Protective clothing against heat and flame — Determination of heat transmission on exposure to flame

Vêtements de protection contre la chaleur et les flammes — Détermination de la transmission de chaleur à l'exposition d'une flamme

Reference number
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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. 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. www.iso.org/patents

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For an explanation on 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 the following URL: http://www.iso.org/iso/foreword.html

The committee responsible for this document is ISO/TC 94, *Personal safety — Protective clothing and equipment,* Subcommittee SC 13, *Protective clothing* and by Technical Committee CEN/TC 162, *Protective clothing including hand and arm protection and lifejackets* in collaboration.

This second edition cancels and replaces the first edition (ISO 9151:1995), of which Clauses/subclauses 2, 3.3, 5.1, 5.2, 5.3, 5.6, 6, 8.1, 8.2, 9.1.2, 9.3.1, 9.3.2, 10, all figures, and Annexes A and B have been technically revised. Tolerances have been added to specified dimensions where appropriate. Results of a recent inter-laboratory trial have been added to Annex A.

To improve reproducibility, the following major modifications have been made from the previous version of this test method:

a) The percentage minimum purity of the propane used has been provided (see 5.2);

b) Two alternative methods for constructing the calorimeter are described with additional information on the figures; additional instructions are given for inserting the calorimeter into the mounting block; and the total mass of the calorimeter and mounting block is specified (see 5.3);

c) Tolerances for the dimensions of machined parts have been added to text and drawings where required;

d) Control of air movement during testing is specified (see Clause 6);

e) The specified relative humidity and temperature ranges for the conditioning and testing atmospheres have been changed (see 8.1 and 8.2);

f) Additional procedures for calibration and stabilization of thermocouple temperature, including a procedure to check on the linearity of the thermocouple output during regulation of the incident heat flux density, have been added (see 9.1.1 and 9.1.2); and

g) Test report requirements have been revised (see Clause 10).

This corrected version of ISO 9151:2016 includes the following changes:

— in 5.3, second paragraph, the tolerance's value has been corrected from "± 002" to "± 0,002";

— in 9.3.3, second paragraph, the reference to Annex A has been corrected to Annex B.

Introduction

Heat transmission through clothing is largely determined by its thickness including any air gaps trapped between adjacent layers. The air gaps can vary considerably in different areas of the same clothing assembly. The present method provides a grading of materials when tested under standard test conditions without an air gap.

Protective clothing against heat and flame — Determination of heat transmission on exposure to flame

1 Scope

This document specifies a method for determining the heat transmission through materials or material assemblies used in protective clothing. Materials may then be ranked by comparing heat transfer indices, which provide an indication of the relative heat transmission under the specified test conditions. The heat transfer index should not be taken as a measure of the protection time given by the tested materials under actual use conditions.

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 5725-2, *Accuracy (trueness and precision) of measurement methods and results — Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method*

IEC 60584-1, *Thermocouples — Part 1: Reference tables*

IEC 60584-3, *Thermocouples — Part 3: Extension and compensating cables — Tolerances and identification systems*

3 Terms and definitions

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

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

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

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

3.1
test specimen
all the layers of fabric or other materials arranged in the order and orientation as used in practice, including, where applicable, undergarment fabrics

3.2
incident heat flux
Q
amount of energy applied to the exposed face of the specimen, per unit time

Note 1 to entry: The unit is kW/m^2.

3.3
heat transfer index
HTI
<flame> mean time, t_m, in whole seconds to achieve a temperature rise of (24 ± 0,2) °C when tested by the method described in this document using a copper disc of mass (18 ± 0,05) g and incident heat flux of (80 ± 2) kW/m^2

Note 1 to entry: Within the context of this document, the heat transfer index refers to the heat transfer between a flame and the test specimen. See Annex A.

4 Principle

A horizontally oriented test specimen is restrained from moving and subjected to an incident heat flux of (80 ± 2) kW/m^2 from the flame of a gas burner placed beneath it. The heat passing through the specimen is measured by means of a small copper calorimeter on top of and in contact with the specimen. The time, in seconds, for the temperature in the calorimeter to rise (24 ± 0,2) °C is recorded. The mean result for three test specimens is calculated as the "heat transfer index (flame)".

5 Apparatus

5.1 General

The apparatus consists of:

— a Meker gas burner;

— a copper disc calorimeter;

— a specimen support frame;

— a calorimeter location plate;

— a support stand;

— suitable measuring and recording equipment;

— a template.

5.2 Gas burner

A flat topped Meker burner with a perforated top area of (38 ± 2) mm diameter and a jet suitable for propane gas shall be used. (See Annex B for possible sources.)

Commercial grade propane of 95 % minimum purity shall be used with the flow being controlled by a fine control valve and flow meter. Alternatively, other gases may be used but such use shall be reported as part of the test report.

5.3 Copper disc calorimeter and mounting block

Copper disc calorimeter, consisting of a disc of copper of minimum 99 % purity, having a diameter of (40 ± 0,05) mm and thickness 1,6 mm, and a mass of (18 ± 0,05) g. The disc shall be weighed before drilling and assembly.

The calorimeter shall be constructed as indicated in Figure 1 (method A) or Figure 2 (method B). Insulated copper-constantan thermocouple wire in accordance with IEC 60584-1 and IEC 60584-3, diameter 0,254 mm ± 0,002 mm shall be used. The constantan wire shall be either inserted into predrilled hole in the centre of the calorimeter and soldered in place with a minimum of solder (method A) or shall be soldered to the back face of the calorimeter as shown in Figure 2 (method B).

The copper wire shall be attached in the same manner, 15 mm to 18 mm from the centre, so as not to interfere with the seating of disc in the mounting block.

NOTE The specified thermocouple wire is equivalent to Type T – 36 gauge.

The calorimeter is located in a mounting block which shall consist of a 89 mm diameter circular piece of asbestos-free non-combustible heat insulating board (See Annex B) of nominal thickness 13 mm (see Figure 3). The thermal characteristics shall comply with the following specification:

Density (750 ± 100) kg/m^3

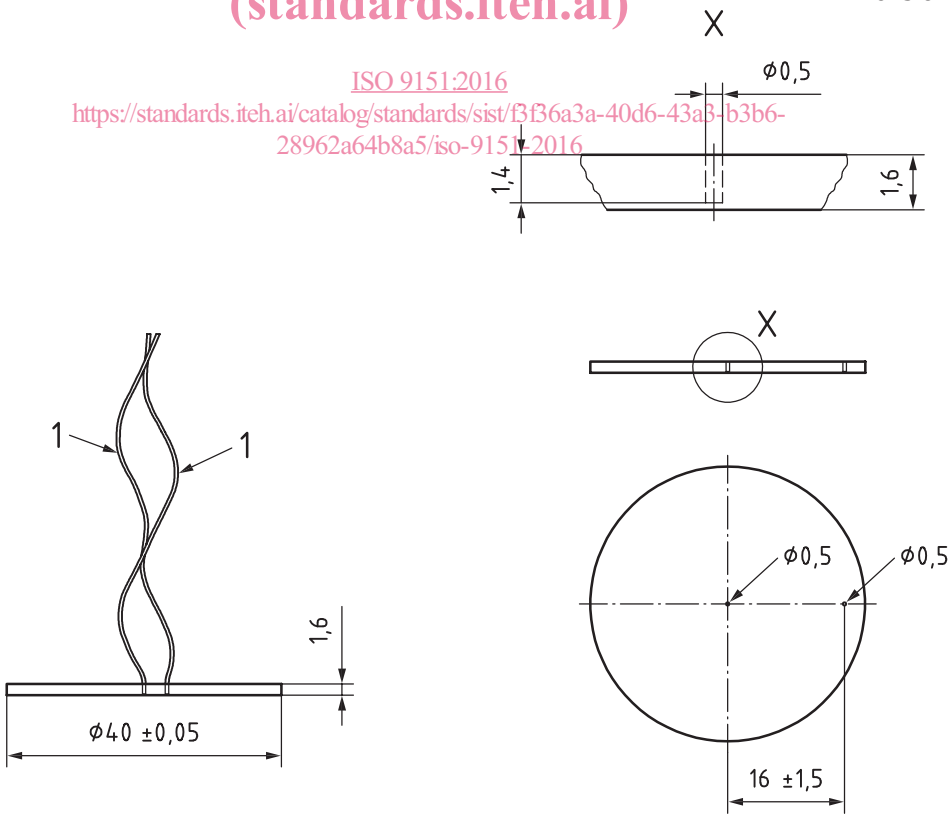
Thermal conductivity (0,180 ± 0,018) W/(m·K)

A circular cavity is machined in the centre of the block to accommodate the disc and an air gap as shown in Figure 3. The disc is held in position using small stainless steel pins (0,45 mm diameter or less) which protrude through the back of the insulating block with sufficient length that they can be used to secure the disc (method A – Figure 4). The mounting pins shall be stainless steel, soft soldered to the calorimeter using the minimum quantity of solder necessary. If method B of mounting the calorimeter is chosen the calorimeter shall be attached to the mounting block with a suitable high temperature adhesive.

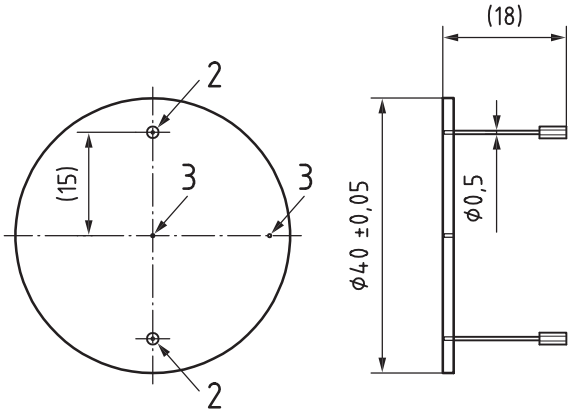
The face of the copper disc shall be flush with the surface of the mounting block. It shall also be coated with a thin layer of an optically black paint having a coefficient of absorption, α, greater than 0,9 (see Annex B).

The total mass of the calorimeter/mounting block assembly shall be (80 ± 10) g.

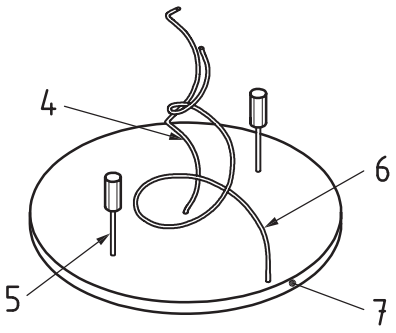
Dimensions in millimetres



a) Calorimeter assembly with mounting pins omitted for clarity



b) Copper calorimeter showing location of mounting pins (additional thermocouple wires omitted for clarity)



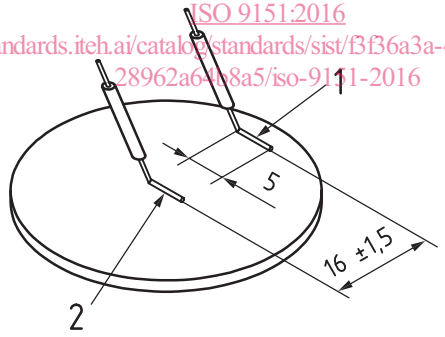
c) Copper calorimeter assembly

Key

1	thermocouple wire	5	mounting pin
2	blind hole for mounting pin	6	copper wire
3	blind hole for thermocouple	7	copper disk
4	constantan wire	X	detail scale 5:1

Figure 1 — Copper calorimeter (method A)

Dimensions in millimetres



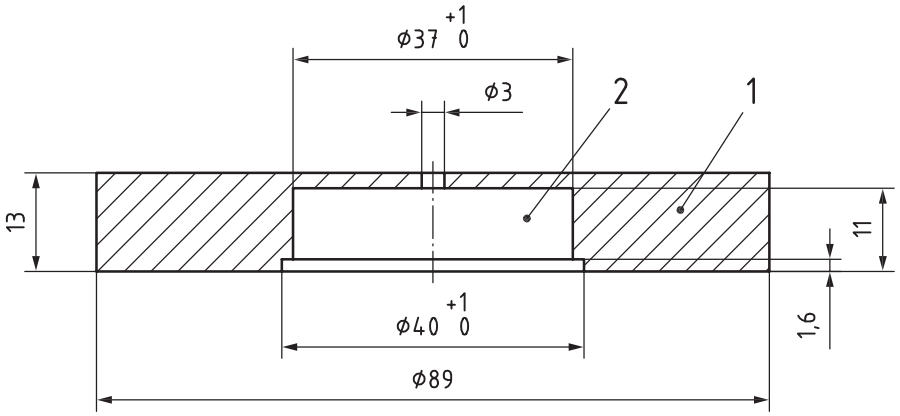
Key

1 copper thermocouple wire, as close as practical to edge of calorimeter

2 constantan thermocouple wire, approximately centre of calorimeter

Figure 2 — Alternative calorimeter construction (method B) (additional thermocouple wires omitted for clarity)

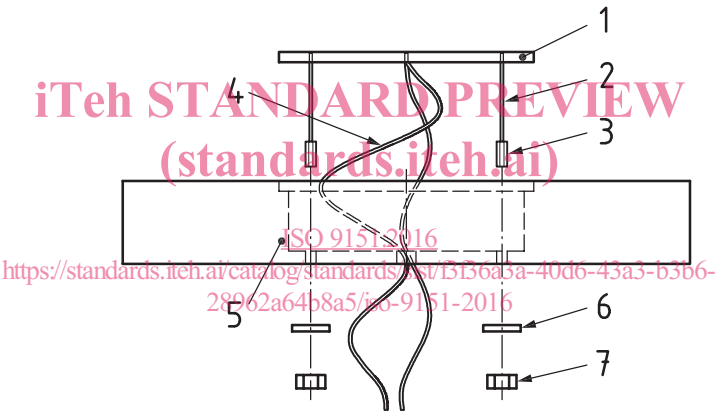
Dimensions in millimetres



Key

1 heat insulation board
2 cavity

Figure 3 — Calorimeter mounting block (informative)



Key

1 copper calorimeter
2 0,45 mm stainless pin
3 2-56 set screw
4 thermocouple wires
5 sensor mounting block
6 flat washer
7 2-56 hex nut

Figure 4 — Calorimeter and mounting block assembly (method A shown)

5.4 Specimen support frame

Specimen support frame consisting of a piece of mild steel (carbon content < 0,5 %) ($150\ ^{+0,5}_{-0}$) mm square and (1,6 ± 0,1) mm thick with a (50 ± 0,5) mm square hole in its centre (see Figure 5). Materials other than mild steel (e.g. copper) may also be used. Tolerances for machined parts shall be $^{+0,5}_{-0}$ mm to fit the calorimeter location plate.