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Clothing for protection against heat and fire — Evaluation of thermal behaviour of materials and material assemblies when exposed to a source of radiant heat

Vêtements de protection contre la chaleur et le feu — Évaluation du comportement thermique de matériaux et d'assemblages de matériaux exposés à une source de chaleur radiante

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Contents

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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.

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.

International Standard ISO 6942 was prepared by Technical Committee ISO/TC 94, *Personal safety — Protective clothing and equipment*, Sub-Committee SC 13, *Protective clothing*.

This second edition cancels and replaces the first edition (ISO 6942:1981), of which it constitutes a technical revision.

Introduction

Protective clothing against radiant heat is worn on different occasions and accordingly the radiation intensity (characterized by the heat flux density) acting on the clothing material extends over a wide range. This International Standard describes two test methods which can be applied to all sorts of materials, but, according to the intended use of the material, the heat flux density has to be chosen properly and the results have to be interpreted correctly.

Industrial workers or firefighters can be exposed to a relatively low radiation intensity over a long period of time. Therefore, the material of their clothing should be tested at a low heat flux density. It should not be changed or destroyed in the test using method A and from the results of the test using method B, the heat transmission factor which characterizes the steady state should be sufficiently low. The times to reach the different heat transfer levels are of less significance and it can even be impossible to determine them in this case.

On the other hand, industrial workers or firefighters can be exposed to medium radiation intensities for relatively short periods of time or to high radiation intensities for very short periods of time. In the latter case, the clothing material can be changed or even destroyed. Therefore, in this case, the materials for the protective clothing should be tested at medium and high heat flux densities. At medium heat flux densities the reaction on testing using method A and the heat transmission factor measured in the test using method B characterize the material. At high heat flux densities, the times to reach the different heat transfer levels are of most importance, whereas it can be impossible to determine the transmission factor in most cases, because the material is changed during the test and no steady state is reached.

Clothing for protection against heat and fire — Evaluation of thermal behaviour of materials and material assemblies when exposed to a source of radiant heat

1 Scope

This International Standard specifies two complementary methods (method A and method B) for the evaluation of the thermal behaviour of materials and material assemblies used in clothing for protection against heat and fire when exposed to a source of radiant heat.

These tests are carried out on representative single or multi-layer textiles or other materials intended for clothing for protection against heat. They are also applicable to assemblies, which correspond to the overall build-up of a heat protective clothing assembly with or without underclothing.

Method A is used for visual assessement of any changes in the material after the action of heat radiation. With method B, the protective effect of the materials is determined. The materials may be tested either by both methods or by only one of them.

The tests according to these two methods serve to classify materials; however, to be able to make a statement or prediction as to the suitability of a material for protective clothing additional criteria must be taken into account.

Since the tests are carried out at room temperature, the results do not necessarily correspond to the behaviour of the materials at higher ambient temperatures and therefore are only to a limited extent suitable for predicting the performance of the protective clothing made from the materials under test.

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 139:1973, *Textiles — Standard atmospheres for conditioning and testing.*

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1 change in appearance of the specimen: All changes in the appearance of the material (shrinkage, formation of char, discoloration, scorching, glowing, melting, etc.).

3.2 heat transfer levels (t_1, t_2 and t_3)**:** Three different levels, characterized by the time from the start of the irradiation until the total heat transmitted through the specimen (t_1 and t_2) or the momentary heat flux at the back of the specimen (t_3) reaches a certain level.

3.3 heat transmission factor (TF)**:** A measure of the fraction of heat transmitted through a specimen exposed to a source of radiant heat. It is numerically equal to the ratio of the transmitted to the incident heat flux density.

3.4 specimen: One or several layers of fabric or other materials taken as specified in this International Standard.

4 Principle

4.1 Method A

A test specimen is fixed to a free-standing frame (specimen holder) and exposed to thermal radiation. There is only a very low conduction of heat away at the back of the specimen; this represents a severe condition for the material. Changes in appearance of the specimen are recorded.

4.2 Method B

A test specimen is fixed over the front of a calorimeter and exposed to thermal radiation. Because of the mass of the calorimeter block, there is conduction of heat away from the back of the specimen; this represents a severe condition for the wearer of protective clothing made from the specimen material. From the recorded data of temperature rise of the calorimeter vs. time the heat transmission factor and the different heat transfer levels are determined.

5 Apparatus

Usual laboratory apparatus and, in particular, the following.

5.1 Radiation source, consisting of six silicon carbide (SiC) heating rods, the technical specifications of which are as follows:

Total length	356 mm
Length of heating part	178 mm
Diameter	7,9 mm
Electrical resistance	3,6 Ω ± 10 % at 1 070 °C

These rods are placed in a U-shaped support made of insulating, flame-resistant material so that they are arranged horizontally and in the same vertical plane.

Figure 1 shows the constructional details of the support and the arrangement of the heating rods, which shall be mounted very freely in the grooves of the support in order to avoid mechanical stress.

Dimensions in millimetres

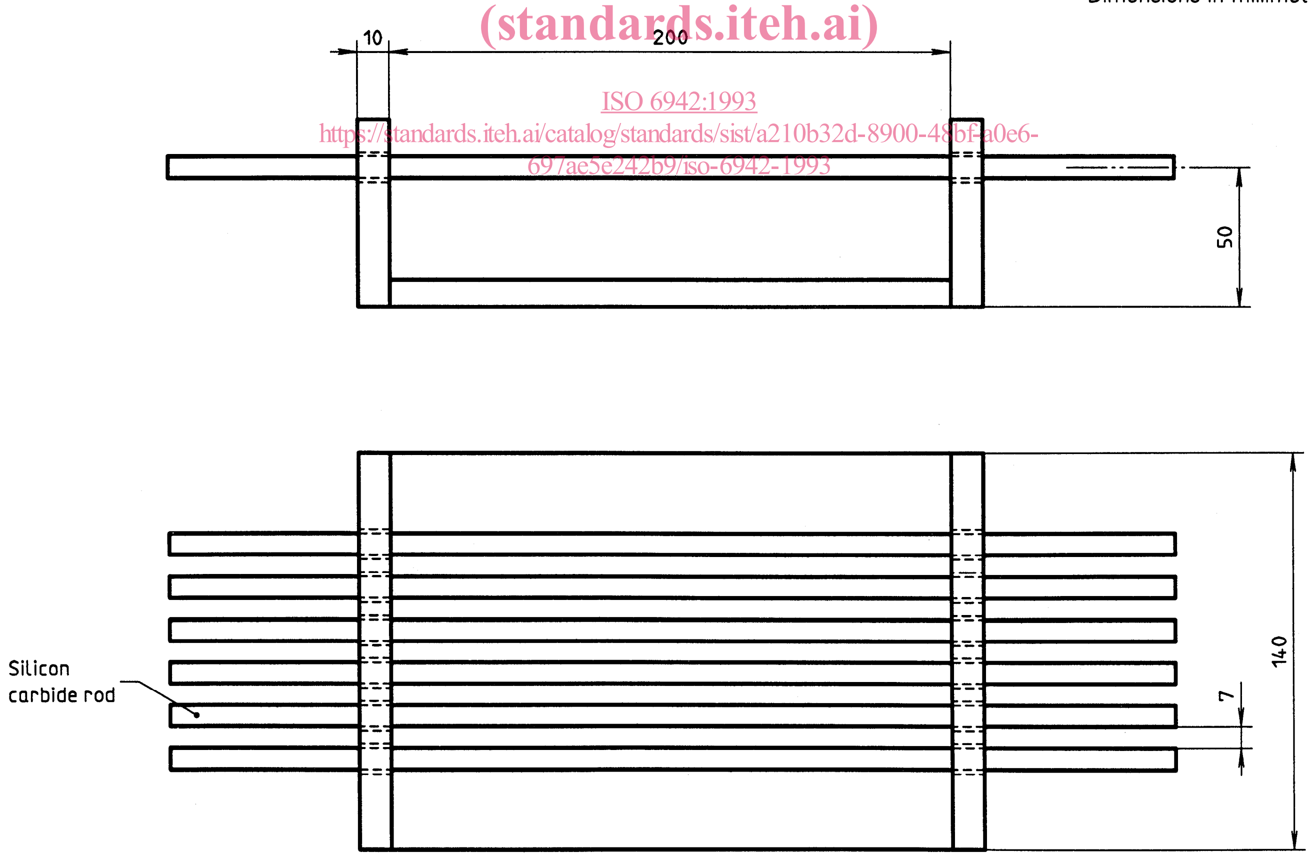

Figure 1 — Source of radiation

A diagram of a possible electricity supply for the radiation source is shown in figure 2. The six rods are arranged into two groups of three rods placed in series. The two groups are connected in parallel and are wired to the 220 V supply through a pre-resistance of 1 Ω. For other supply voltages, the circuit shall be changed accordingly. If the supply voltage shows variations of more than ± 1 % during a measurement, a means of stabilization shall be provided.

NOTE 1 The electrical connections of the heating rods should be made carefully (e.g. by means of a stranded aluminium band), taking into consideration that they become very hot. Precautions should be taken to avoid short circuits between the rods.

The correct operation of the radiation source can be checked by using an infrared thermometer to measure the temperature of the silicon carbide rods. After allowing the radiation source to burn in for about 5 min, the rods should have a temperature of about 1 100 °C.

5.2 Test frame

Figure 3 shows a possible construction for the test frame. Basically, it consists of two plates of non-combustible board about 300 mm wide and 20 mm thick.

The vertical surface of the frame shall be covered by a cooled screen with a square opening of sides 60 mm which can be closed by a separate movable screen which is also cooled. Figure 4 shows a possible design of the cooling system made from a cooper plate with copper pipes welded on it. The screen is used to shield the calorimeter from the source of radiation before the test starts.

The source of radiation shall be mounted in front of the test frame so that the distance between the two can easily be adjusted (e.g. on slide bar guides). Care should be taken to ensure that the SiC rods are always parallel to the front side of the test frame and that the central points of the radiation source and the opening in the front of the test frame are aligned.

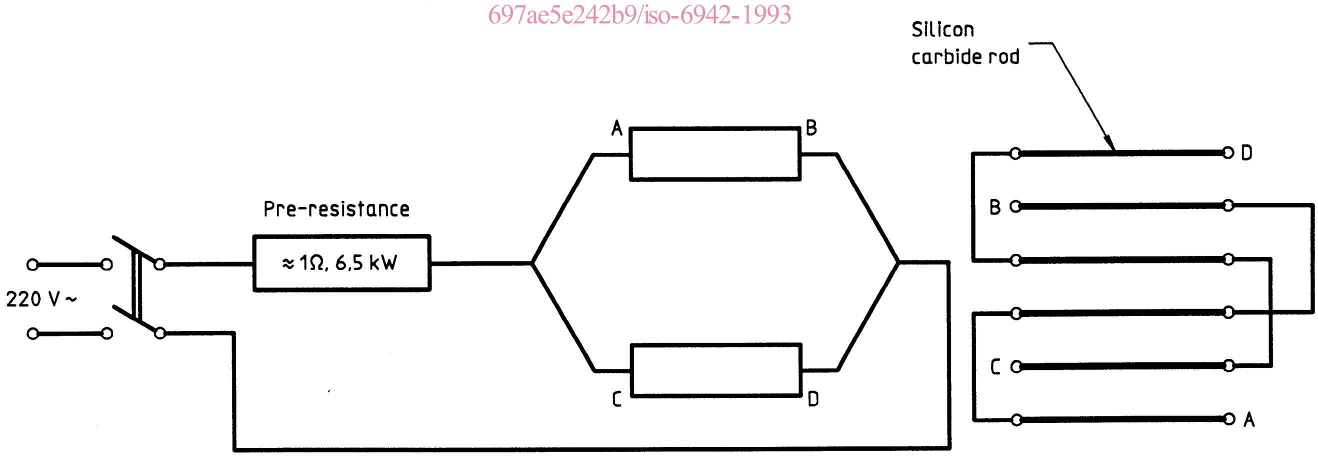

Figure 2 — Circuit diagram for heating rods

Dimensions in millimetres

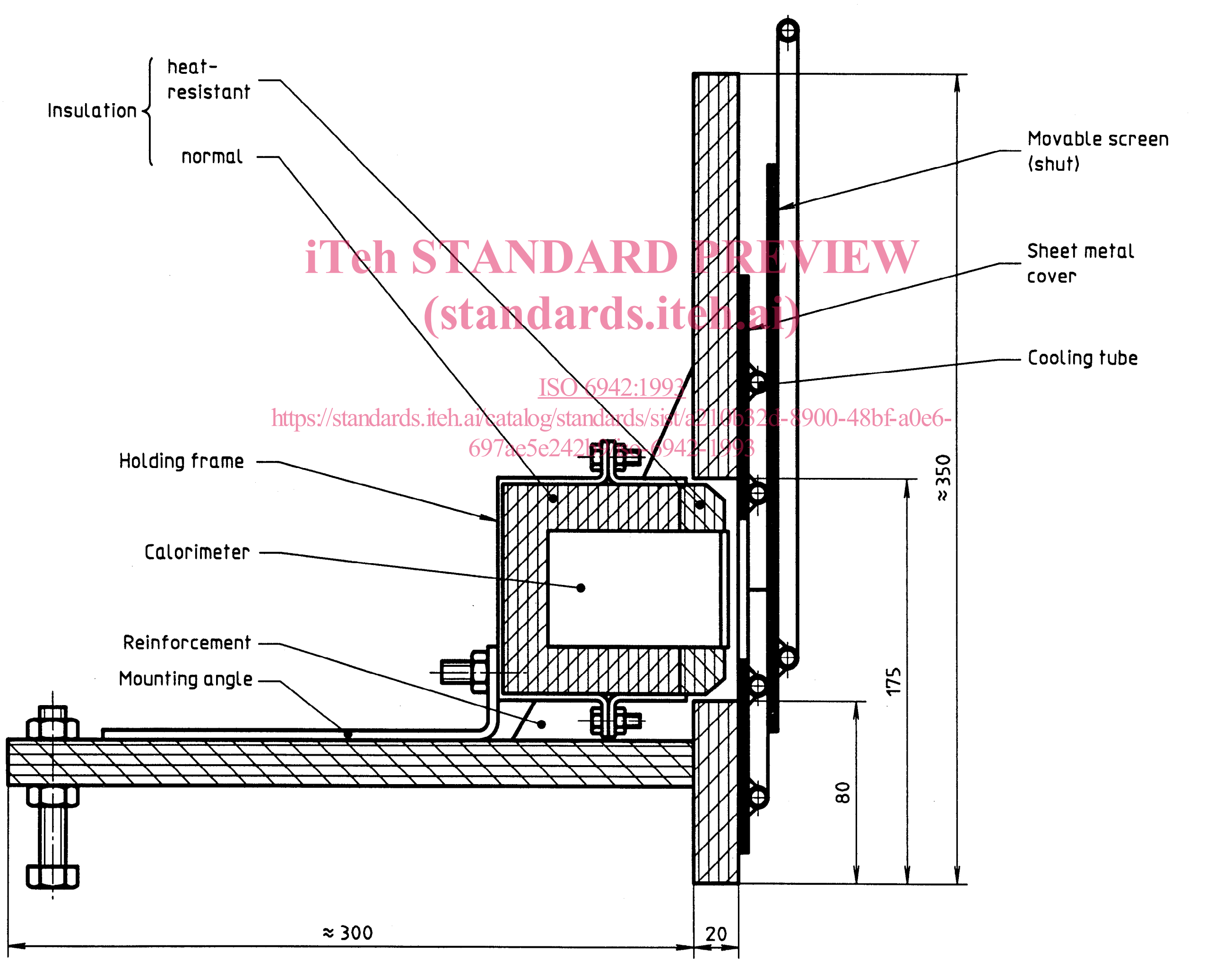

Figure 3 — Test frame

Dimensions in millimetres

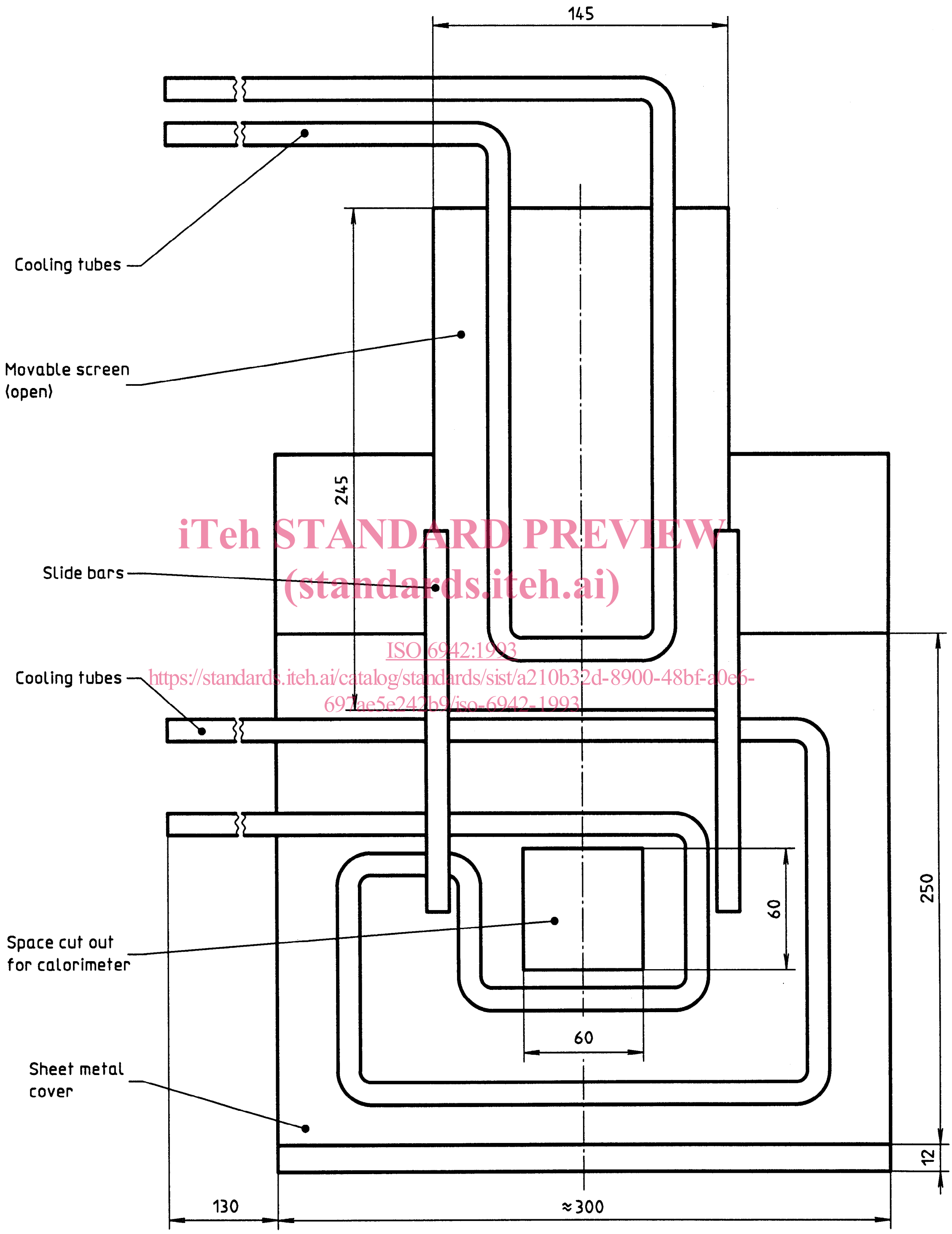

Figure 4 — Cooling system

5.3 Specimen holder, made from stainless steel sheet 1 mm thick , as illustrated in figure 5, which is fastened to the horizontal plate of the test frame with a suitable holding device, so that it fits concentrically into the opening of the vertical plate of the test frame.

For testing, one of the narrow sides of the specimen (see clause 6) is fastened to one of the flaps (e.g. with a clamp). The other narrow side of the specimen is pulled over the other flap and is held in tension under a force of 2 N by means of a suitable device (e.g. cord and weight). If the tested material consists of several layers, each layer shall be seperately tensioned by a force of 2 N. In testing by method B, the calorimeter with insulation is inserted and fixed in the opening of the specimen holder.

NOTE 2 For convenience, two different specimen holders can be used for method A and method B, the one for method B being integrated into the holding frame of the calorimeter (see figure 3).

5.4 Calorimeter, consisting of a block of pure (at least 99,5 %) aluminium of dimensions as given in figure 6 with two borings B and C.

Dimensions in millimetres

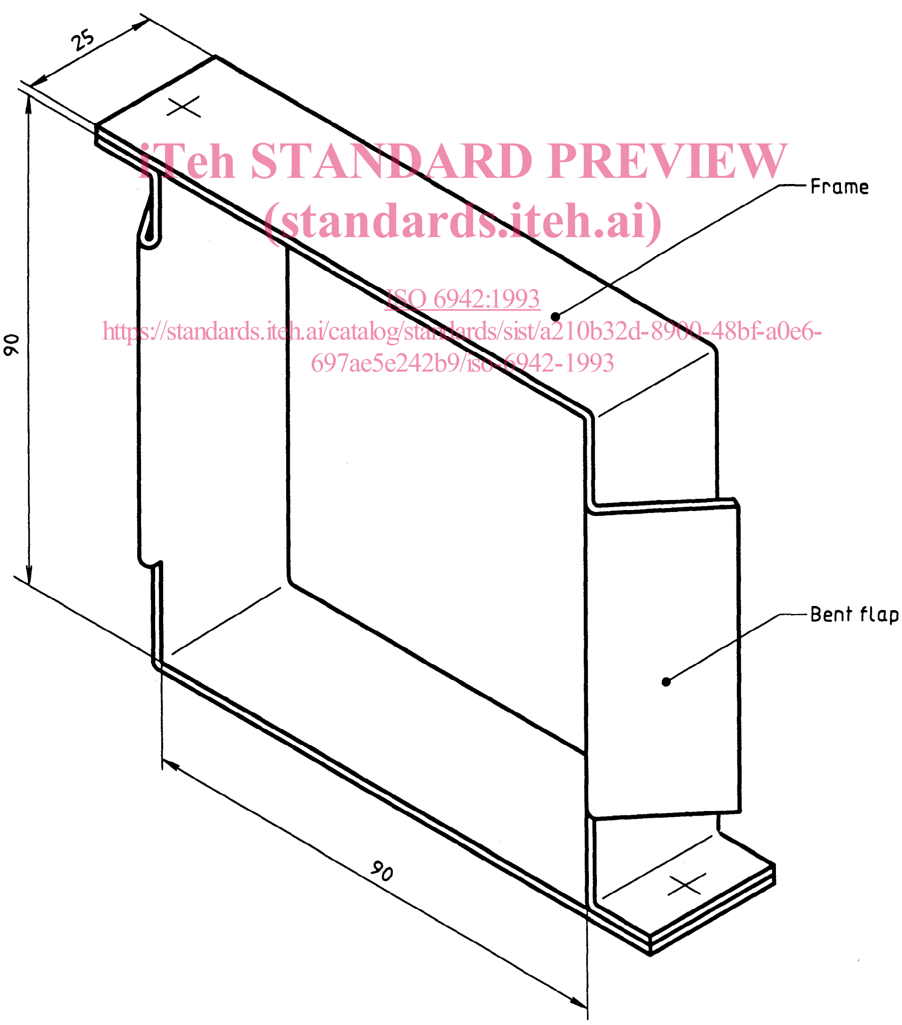

Figure 5 — Specimen holder

Dimensions in millimetres

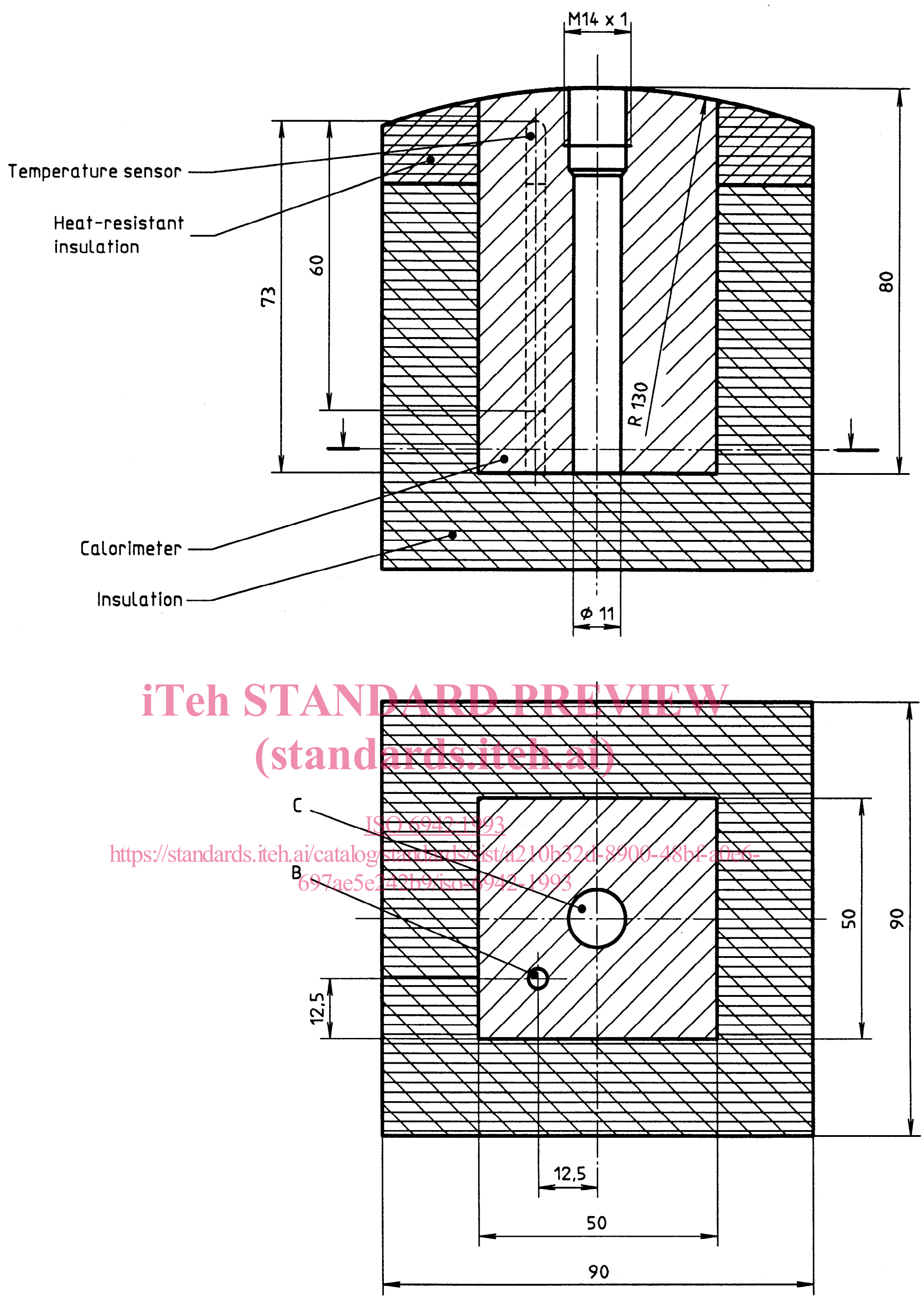

Figure 6 — Calorimeter block

In the smaller boring B, a temperature sensor (e.g. a platinum resistor) with a sensitive length of at least 60 mm is inserted. The diameter of the boring B is adapted to the diameter of the sensor.

In the larger boring C, an aluminium cylinder is screwed in, around which a heating coil consisting of constantan resistance wire is wound. The dimensions of the aluminium cylinder are given in figure 7. The resistance of the heating coil mounted in the calorimeter block (approximately 700 Ω) shall be measured to the nearest ± 0,2 %. After connecting up the heating coil, the front surface of the