

# INTERNATIONAL STANDARD

**IEC**  
**60335-2-81**

Second edition  
2002-10

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## **Household and similar electrical appliances – Safety –**

### **Part 2-81: Particular requirements for foot warmers and heating mats**

*Appareils électrodomestiques et analogues –  
Sécurité –*

*Partie 2-81:  
Règles particulières pour les chancelières et  
les carpettes chauffantes électriques*



Reference number  
IEC 60335-2-81:2002(E)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**HOUSEHOLD AND SIMILAR ELECTRICAL APPLIANCES –  
SAFETY –**

**Part 2-81: Particular requirements for foot warmers  
and heating mats**

FOREWORD

- 1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of the IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested National Committees.
- 3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical specifications, technical reports or guides and they are accepted by the National Committees in that sense.
- 4) In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.
- 5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.
- 6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights.

This part of International Standard IEC 60335 has been prepared by IEC technical committee 61: Safety of household and similar electrical appliances.

This second edition cancels and replaces the first edition published in 1997. It constitutes a technical revision.

The text of this part of IEC 60335 is based on the following documents:

FDIS	Report on voting
61/2178/FDIS	61/2259/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This part 2 is to be used in conjunction with the latest edition of IEC 60335-1 and its amendments. It was established on the basis of the fourth edition (2001) of that standard.

NOTE 1 When "Part 1" is mentioned in this standard, it refers to IEC 60335-1.

This part 2 supplements or modifies the corresponding clauses in IEC 60335-1, so as to convert that publication into the IEC standard: Safety requirements for electric foot warmers and heating mats.

When a particular subclause of Part 1 is not mentioned in this part 2, that subclause applies as far as is reasonable. When this standard states "addition", "modification", or "replacement", the relevant text in Part 1 is to be adapted accordingly.

NOTE 2 The following numbering system is used:

- subclauses, tables and figures that are numbered starting from 101 are additional to those in Part 1;
- unless notes are in a new subclause or involve notes in Part 1, they are numbered starting from 101, including those in a replaced clause or subclause;
- additional annexes are lettered AA, BB, etc.

NOTE 3 The following print types are used:

- requirements: in roman type;
- *test specifications: in italic type;*
- notes: in small roman type.

Words in **bold** in the text are defined in Clause 3. When a definition concerns an adjective, the adjective and the associated noun are also in bold.

The committee has decided that the contents of this publication will remain unchanged until 2004. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

The following differences exist in the countries indicated below.

- 3.1.9: Normal operation is different (USA).
- 6.1: Class 0 appliances are allowed if their rated voltage does not exceed 150 V (Japan).
- 6.1: Class 0 and class I appliances are allowed (USA).
- 19.2: The test is different (USA).
- 21.101: The test is different (USA).
- 22.101: The tests are different (USA).

A bilingual version of this publication may be issued at a later date.

## INTRODUCTION

It has been assumed in the drafting of this International Standard that the execution of its provisions is entrusted to appropriately qualified and experienced persons.

This standard recognizes the internationally accepted level of protection against hazards such as electrical, mechanical, thermal, fire and radiation of appliances when operated as in normal use taking into account the manufacturer's instructions. It also covers abnormal situations that can be expected in practice.

This standard takes into account the requirements of IEC 60364 as far as possible so that there is compatibility with the wiring rules when the appliance is connected to the supply mains. However, national wiring rules may differ.

If an appliance within the scope of this standard also incorporates functions that are covered by another part 2 of IEC 60335, the relevant part 2 is applied to each function separately, as far as is reasonable. If applicable, the influence of one function on the other is taken into account.

This standard is a product family standard dealing with the safety of appliances and takes precedence over horizontal and generic standards covering the same subject.

An appliance that complies with the text of this standard will not necessarily be considered to comply with the safety principles of the standard if, when examined and tested, it is found to have other features that impair the level of safety covered by these requirements.

An appliance employing materials or having forms of construction differing from those detailed in the requirements of this standard may be examined and tested according to the intent of the requirements and, if found to be substantially equivalent, may be considered to comply with the standard.

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# HOUSEHOLD AND SIMILAR ELECTRICAL APPLIANCES – SAFETY –

## Part 2-81: Particular requirements for foot warmers and heating mats

### 1 Scope

This clause of Part 1 is replaced by the following.

This International Standard deals with the safety of electric **foot warmers** and **heating mats** for household and similar purposes, their **rated voltage** being not more than 250 V.

Appliances not intended for normal household use but which nevertheless may be a source of danger to the public, such as appliances intended to be used by laymen in shops, in light industry and on farms, are within the scope of this standard.

As far as is practicable, this standard deals with the common hazards presented by appliances that are encountered by all persons in and around the home. However, in general, it does not take into account

- the use of appliances by young children without supervision;
- playing with the appliance by young children.

NOTE 101 Attention is drawn to the fact that

- for appliances intended to be used in vehicles or on board ships or aircraft, additional requirements may be necessary;
- in many countries additional requirements are specified by the national health authorities, the national authorities responsible for the protection of labour, and similar authorities.

NOTE 102 This standard does not apply to

- appliances specifically intended for use under medical supervision;
- electric blankets and pads (IEC 60335-2-17);
- electrically heated carpets;
- electrical heating appliances for breeding and rearing animals (IEC 60335-2-71).

### 2 Normative references

This clause of Part 1 is applicable except as follows.

*Addition:*

ISO 2439, *Polymeric materials, cellular flexible. Determination of hardness (indentation technique)*.

### 3 Definitions

This clause of Part 1 is applicable except as follows.

#### 3.1.9 Replacement:

##### **normal operation**

operation of the appliance under the following conditions

**Foot warmers** are unfilled and placed on a horizontal surface.

**Heating mats** are placed on a horizontal surface and covered by a piece of expanded polystyrene having dimensions approximately 300 mm × 150 mm × 50 mm.

NOTE 101 The density of the polystyrene is approximately  $20 \text{ kg/m}^3 \pm 5 \text{ kg/m}^3$ .

### 3.101

#### **foot warmer**

appliance into which the user's feet are inserted in order to warm them

### 3.102

#### **heating mat**

appliance having an area not exceeding 0,5 m<sup>2</sup>, on which the user's feet are placed in order to warm them

## 4 General requirement

This clause of Part 1 is applicable.

## 5 General conditions for the tests

This clause of Part 1 is applicable except as follows.

### 5.2 Addition:

*A 15 m length of heating element or internal wiring is required for the tests of 21.102.*

*Twelve samples of the enclosure material of **foot warmers**, each having dimensions 200 mm × 100 mm, are required for the test of 30.101.*

### 5.3 Addition:

*Before testing is started, the appliance is laundered or cleaned twice in accordance with the instructions.*

### 5.5 Addition:

*If the appliance is provided with a **detachable cover**, the tests are carried out with or without this cover, whichever is more unfavourable.*

## 6 Classification

This clause of Part 1 is applicable except as follows.

### 6.1 Modification:

Appliances shall be **class II** or **class III**.

### 6.2 Addition:

Appliances shall be at least IPX1.

## 7 Marking and instructions

This clause of Part 1 is applicable except as follows.

### 7.12 Addition:

The instructions shall state the substance of the following:

- the appliance is not to be used if there are signs of damage;
- the appliance is not to be used for warming animals;
- details regarding laundering or cleaning.

The instructions for **foot warmers** shall state that outdoor shoes must be removed before use.

The instructions for **heating mats** shall state that the appliance has to be repaired or replaced if the cover is worn. They shall explain how such wear can be observed.

## 8 Protection against access to live parts

This clause of Part 1 is applicable.

## 9 Starting of motor-operated appliances

This clause of Part 1 is not applicable.

## 10 Power input and current

This clause of Part 1 is applicable.

## 11 Heating

This clause of Part 1 is applicable except as follows:

### 11.2 Modification:

*Appliances are placed as near as possible to one wall of the test corner and away from the other wall.*

### 11.3 Addition:

*Thermocouples attached to the small blackened disks are also used for measuring the temperature rise of the surface of the appliance.*

### 11.7 Replacement:

*Appliances are operated until steady conditions are established.*

### 11.8 Modification:

*When polyvinyl chloride is used for insulating heating elements, the temperature rise of the insulation shall not exceed 80 K.*

### Addition:

*The temperature rise of surfaces likely to be in contact with the user's feet shall not exceed 40 K.*

## 12 Void

## 13 Leakage current and electric strength at operating temperature

This clause of Part 1 is applicable except as follows.

### 13.2 Modification:

*When testing the top surface of **heating mats**, the dimensions of the metal foil are 300 mm × 150 mm.*

NOTE 101 If the **heating mat** is reversible, each surface is tested in turn.

*Addition:*

***Foot warmers** are also tested with the inside surface completely covered with metal foil.*

## 14 Transient overvoltages

This clause of Part 1 is applicable.

## 15 Moisture resistance

This clause of Part 1 is applicable.

## 16 Leakage current and electric strength

This clause of Part 1 is applicable except as follows.

### 16.2 Modification:

*When testing the top surface of **heating mats**, the dimensions of the metal foil are 300 mm × 150 mm.*

NOTE 101 If the **heated mat** is reversible, each surface is tested in turn.

*Addition:*

***Foot warmers** are also tested with the inside surface completely covered with metal foil.*

## 17 Overload protection of transformers and associated circuits

This clause of Part 1 is applicable.

## 18 Endurance

This clause of Part 1 is not applicable.

## 19 Abnormal operation

This clause of Part 1 is applicable except as follows.

### 19.2 Addition:

The appliance is covered partially or completely, whichever is more unfavourable, with a sheet of open-cell polyether approximately 36 mm thick, having the following properties:

- cell count  $18 \begin{smallmatrix} +2 \\ 0 \end{smallmatrix}$  per cm;
- specific mass  $30 \text{ kg/m}^3 + \begin{smallmatrix} +10 \\ 0 \end{smallmatrix} \%$ ;
- hardness 120 N to 170 N at 40 % impression, measured according to ISO 2439.

If the **foot warmer** has a flexible part that covers the user's legs, this part is folded onto the foot part before covering.

A plywood board, having dimensions approximately 500 mm × 500 mm × 20 mm, is placed on top of the polyether sheet covering **foot warmers**.

### 19.4 Modification:

**Heating mats** are tested without being covered by the polystyrene block.

### 19.13 Addition:

The temperature rise of the insulation of heating elements shall not exceed 145 K.

## 20 Stability and mechanical hazards

This clause of Part 1 is applicable.

## 21 Mechanical strength

This clause of Part 1 is applicable except as follows.

*Addition:*

**Foot warmers** are also subjected to the test of 21.101.

**21.101** A plywood board, having dimensions approximately 300 mm × 150 mm × 20 mm with rounded edges, is placed in the leg section of the **foot warmer** as shown in Figure 101. A mass of 30 kg is placed on the board, which is allowed to drop freely from a height of 200 mm above the base, so that the leg section is flexed and the appliance is compressed between the board and the supporting surface. If the **foot warmer** does not have a leg section, the board is allowed to fall onto the top surface.

The test is carried out 1 000 times at a rate of six times per min.

The test shall not result in

- damage to the enclosure or displacement of heating elements to such an extent that compliance with the standard is impaired;
- open-circuiting of heating elements or controls;
- breakage of more than 10 % of the strands of internal wiring;
- failure of constructional stitching, or breakage of glued or welded joints, to such an extent that compliance with the standard is impaired.

NOTE An example of damage to the enclosure that could impair compliance with the standard is a tear in the enclosure. Small holes in textiles that are not part of electrical insulation or do not provide protection against moisture are ignored.

**21.102** The insulation of heating elements and internal wiring shall retain adequate flexibility and insulating characteristics throughout the life of the appliance.

*Compliance is checked by the tests of 21.102.1 and by the tests of 21.102.2 and 21.102.3 when the insulation exceeds*

- a temperature rise of 50 K during the test of Clause 11,
- or
- a temperature rise of 110 K during the tests of Clause 19.

*The tests are carried out on separate samples of heating element or internal wiring.*

*For the test of 21.102.1, one sample measuring approximately 4 m in length is required. For the tests of 21.102.2, at least 12 samples are required, each having a length of 300 mm. For the test of 21.102.3, 12 samples are required, each having a length of 300 mm.*

**21.102.1** *The sample of heating element or internal wiring is attached to the equipment shown in Figure 102. This equipment has a carrier with two pulleys, each having a groove with a radius of 4 mm, the diameter at the base of the groove being 25 mm. The pulleys are arranged so that the sample is horizontal where it passes between them.*

NOTE 1 For samples not having a circular cross-section, the form of the groove in the pulley is suitably modified.

*The sample is stretched over the pulleys, each end being loaded with a mass of 0,25 kg. If necessary, the mass at each end is increased in steps of 0,1 kg in order to ensure that the wires leaving the pulleys are parallel to each other. Restraining clamps are positioned so that the pull is always applied by the mass in the opposite direction from which the carrier is moving.*

*The carrier moves over a distance of 1 m with a constant speed of approximately 0,33 m/s for 25 000 cycles.*

NOTE 2 A cycle is two movements, one in each direction.

*The sample shall not break during the test.*

NOTE 3 A monitoring current not exceeding 50 mA may be passed through the sample during the test.

*The sample is then immersed in water containing approximately 1 % NaCl. A d.c. voltage of approximately 500 V is applied between the conductor and the saline solution.*

*The insulation resistance is measured 1 min after immersion and shall be at least 1 M $\Omega$ .*

**21.102.2** *The conductors are pulled out from 12 samples of heating element or internal wiring. If this is not possible, the insulation is slit longitudinally, the conductor is removed and the insulation allowed to close.*

*Six of the samples are conditioned by suspending them vertically so that they hang freely in a heating cabinet at a temperature of 125 °C  $\pm$  2 °C for 336 h. The samples are removed from the cabinet and allowed to cool down to room temperature. When the material has stabilized, the length of the samples is measured and shall not be less than 90 % of the original length.*

NOTE 1 PVC material is considered to have stabilized by 16 h after removal from the cabinet.

NOTE 2 The heating cabinet is to have forced air circulation in order to ensure that there is no temperature gradient over the length of the samples.

*The 12 samples are placed in a tensile machine, in turn, so that the length between the clamps is at least 50 mm. The machine is operated at a uniform speed of 500 mm/min  $\pm$  50 mm/min. The force and elongation at the instant of rupture are determined.*

Results obtained from any sample that ruptured at a force differing from the average value by more than 10 %, and from samples that ruptured within a distance of 15 mm from the clamp, are disregarded. Additional samples are tested in order to obtain 12 valid results.

The elongation of each of the unconditioned samples shall not be less than 100 % and their tensile strength shall not be less than 8,75 MPa.

The average value of both the elongation and tensile strength of the conditioned samples shall be not less than 75 % of the average value determined for the unconditioned samples.

**21.102.3** A 10 mm length of insulation is removed from each end of 12 samples of heating element or internal wiring.

Six of the samples are wound in a close helix of six turns on a metal mandrel having a diameter approximately equal to the external diameter of the samples. Together with the remaining six samples, they are placed in a heating cabinet at a temperature of  $125\text{ °C} \pm 2\text{ °C}$  for 336 h. The samples are removed from the cabinet and allowed to cool down to room temperature.

When the material has stabilized, the other six samples are also wound on the mandrel in the same way.

NOTE 1 PVC material is considered to have stabilized by 16 h after removal from the cabinet.

NOTE 2 The heating cabinet is to have forced air circulation in order to ensure that there is no temperature gradient over the length of the samples.

The mandrel is immersed for 1 h in water containing approximately 1 % NaCl. The samples are then subjected to a test voltage of 1 000 V for **class II appliances** and 500 V for **class III appliances**. The voltage is applied for 1 min between the conductors and the solution and there shall be no breakdown.

The samples are unwound from the mandrel and inspection shall show that there are no visible cracks.

## 22 Construction

This clause of Part 1 is applicable except as follows.

**22.101** Appliances shall be constructed so that heating elements and internal wiring are retained in their intended position. No part of the heating element shall cross over another part of the heating element.

Crossing of internal wiring shall be avoided as far as possible. When this is unavoidable, the wiring shall be secured in order to prevent any relative movement.

*Compliance is checked by inspection.*

**22.102** There shall be no significant change in the position of the heating elements if the stitching retaining them in position is broken.

*Compliance is checked by inspection after breaking the thread in the most unfavourable place.*

**22.103** The insulation of heating elements and internal wiring, except in **class III appliances**, shall be integral with the conductor.

*Compliance is checked by inspection.*

## 23 Internal wiring

This clause of Part 1 is applicable.

## 24 Components

This clause of Part 1 is applicable except as follows.

### 24.1.4 Modification:

**Thermostats** are operated for 100 000 cycles of operation and **self-resetting thermal cut-outs** for 10 000 cycles of operation.

### 24.2 Modification:

Appliances may be fitted with switches in flexible cords.

## 25 Supply connection and external flexible cords

This clause of Part 1 is applicable except as follows.

### 25.1 Modification:

Appliances shall not be provided with an appliance inlet.

### 25.5 Addition:

**Type Z attachment** is allowed.

### 25.15 Modification:

The pull force is increased to 60 N.

## 26 Terminals for external conductors

This clause of Part 1 is applicable.

## 27 Provision for earthing

This clause of Part 1 is applicable.

## 28 Screws and connections

This clause of Part 1 is applicable.

## 29 Clearances, creepage distances and solid insulation

This clause of Part 1 is applicable except as follows.

### 29.3 Addition:

The requirement does not apply to the part containing heating elements.

### 30 Resistance to heat and fire

This clause of Part 1 is applicable except as follows.

#### 30.1 Addition:

*The test is not applied to enclosures that are likely to be flexed in normal use.*

#### 30.2 Modification:

*The test is not carried out on textiles and similar materials forming the enclosure of **foot warmers**.*

##### 30.2.2 Not applicable.

**30.101** Textiles and similar materials forming the enclosure of **foot warmers** shall be adequately resistant to ignition.

*Compliance is checked by a spark ignition test that is carried out on six samples of the material. Each sample has dimensions approximately 200 mm × 100 mm. Any pieces of heating element and trimming are removed from the samples.*

*The test fixture, as shown in Figure 103, has two brass electrodes 3 mm in diameter that are supported by brass pillars mounted on a base plate of insulating material so that their axes are aligned. The base plate also supports a platform of insulating material, having dimensions of 100 mm × 100 mm, and located centrally between the brass pillars. Provision is made for the height of the platform to be adjusted.*

*One of the electrodes is fixed in position while the other electrode is movable, thus allowing the sample to be inserted. The tip of the fixed electrode has an angle of 45°. The electrode is positioned so that the point furthest from the brass pillar is at the top and at a distance of approximately 3 mm from the centre of the platform. The movable electrode has a flat end.*

*The lower member of a two-part hardwood mask, as shown in detail A of Figure 103, is placed on the adjustable platform in the position indicated.*

*The test fixture, including the upper member of the mask as shown in detail B of Figure 103, is placed in a heating cabinet having a door with an inspection window, air being circulated by natural convection. The electrodes are connected in series with an adjustable non-inductive resistor to a supply having a sinusoidal output voltage of 10 kV and a characteristic such that the output voltage does not decrease by more than 100 V when a current of 1 mA is flowing.*

*The temperature of the heating cabinet is raised to 65 °C ± 2 °C. The electrodes are then short-circuited and the resistor adjusted so that a current of 1 mA flows. The supply is then disconnected and the samples are placed in the cabinet for a period of 3 h.*

*Without removing the fixture from the heating cabinet, the movable electrode is withdrawn and one sample is pulled over the fixed electrode so that the electrode is situated centrally in the space normally occupied by the heating element. The sample is adjusted so that its end is approximately level with the edge of the adjustable platform. The movable electrode is then inserted into the other end of the element space and is fixed so that the distance between the electrodes is 6,0 mm ± 0,1 mm. The sample is smoothed out and the upper member of the mask is placed in position. The door of the heating cabinet is then closed for a further period of 5 min in order to stabilise the temperature.*

*The supply is switched on and sparks are allowed to pass between the electrodes for a period of 2 min. If the sample ignites, the time from the instant of switching on until the flame reaches the inner edge of the mask is recorded, any ignition of surface fibres that last no more than 3 s being ignored. If the sample does not ignite, a time of 120 s is recorded.*

*The sample is then removed and repositioned between the electrodes with the other surface uppermost and so that the opposite end is subjected to the test.*

*The test is repeated on the other five samples.*

*If any time recorded is less than 30 s, the complete test is repeated on a second set of six samples. In this case, no sample shall have a recorded time less than 30 s.*

*The average of the 12 values recorded is calculated and shall not be less than 80 s. All values differing by more than 30 s from the average are ignored and, if necessary, the average of the remaining values is recalculated.*

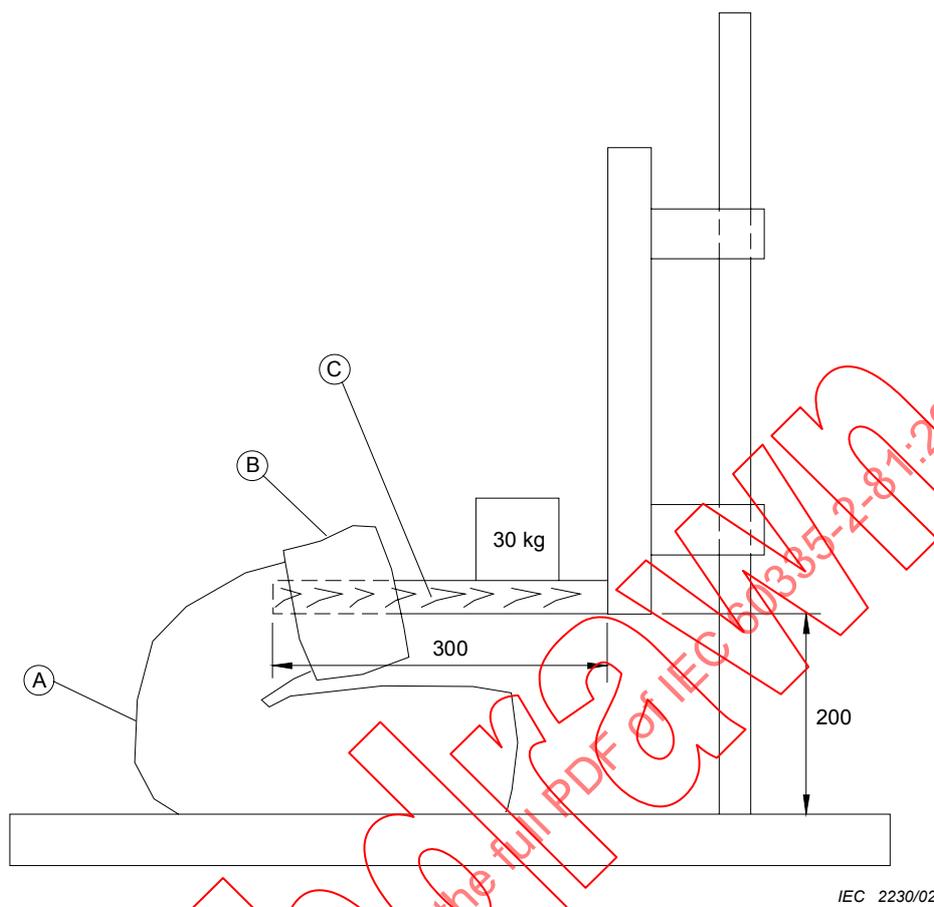
### **31 Resistance to rusting**

This clause of Part 1 is applicable.

### **32 Radiation, toxicity and similar hazards**

This clause of Part 1 is applicable.

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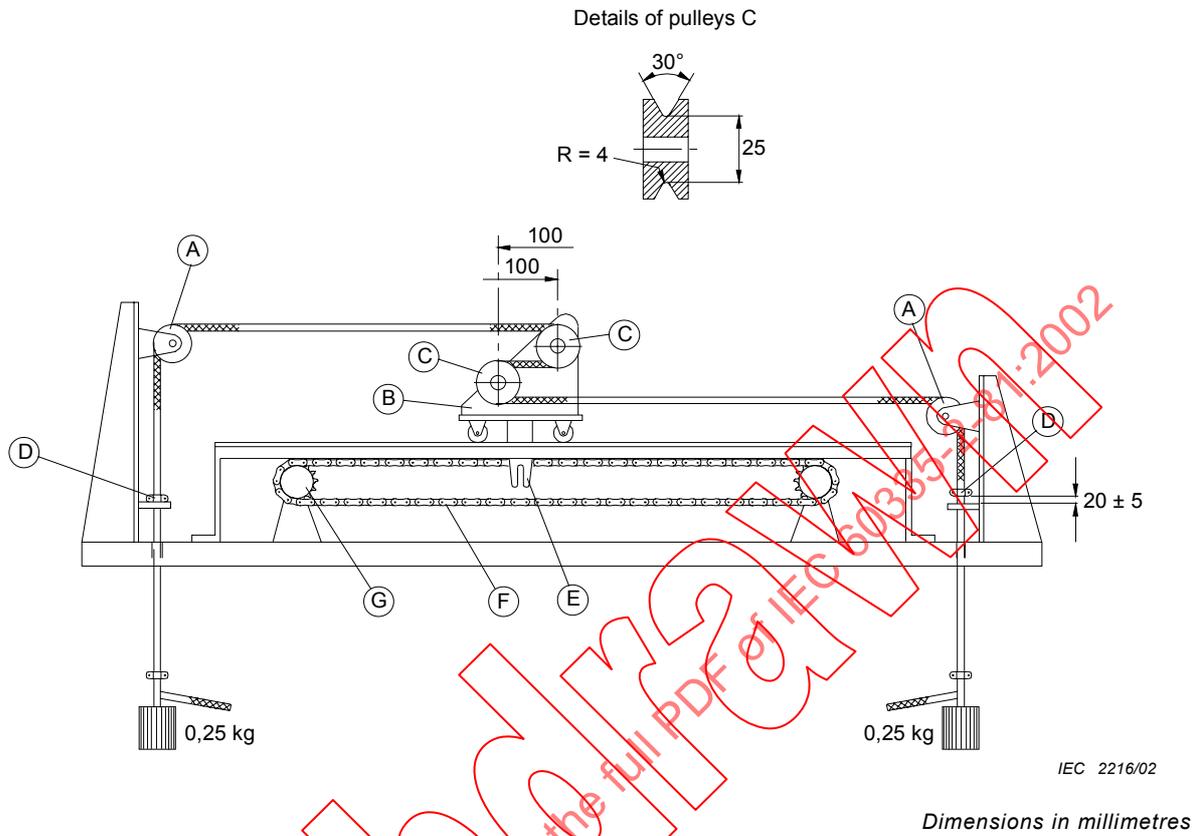


*Dimensions in millimetres*

**Key**

- A Foot warmer
- B Leg section
- C Plywood board, 150 mm wide

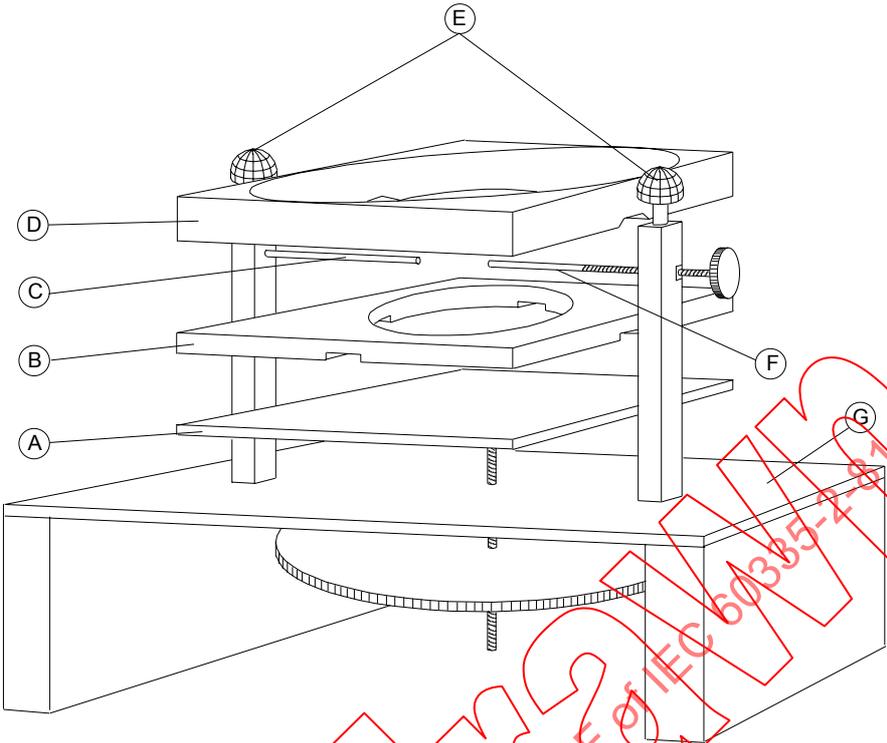
**Figure 101 – Equipment for the flexing test for foot warmers**



**Key**

- A Pulley having a diameter > 50 mm
- B Carrier
- C Grooved pulley
- D Restraining clamp
- E Engagement pin
- F Chain having a pitch of 12,7 mm
- G Sprocket having 20 teeth with a pitch circle diameter of 88,9 mm

**Figure 102 – Equipment for flexing heating elements and internal wiring**

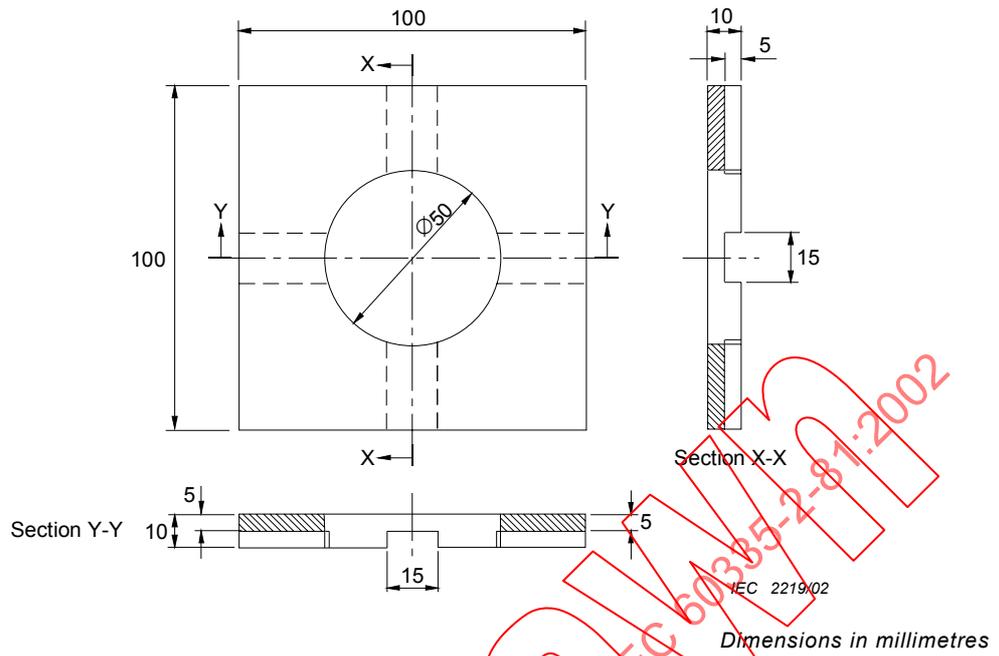


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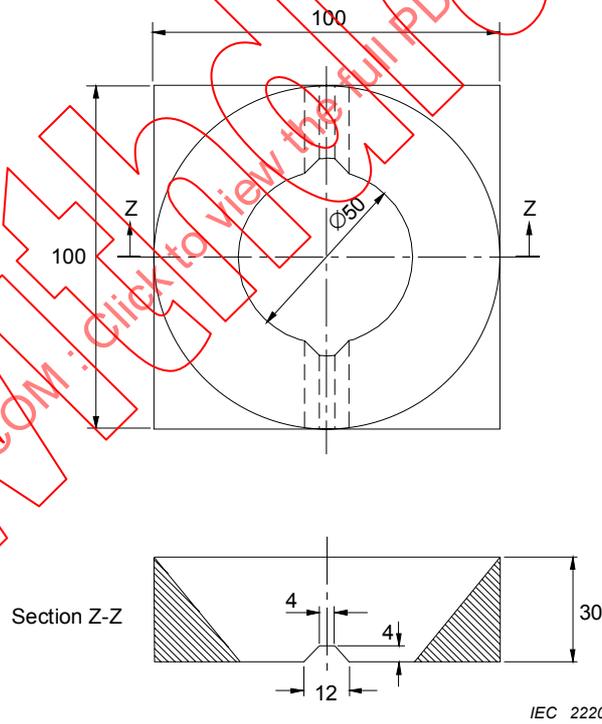
**Key**

- A Adjustable platform
- B Lower part of mask (see detail A of Figure 103a)
- C Fixed electrode
- D Upper part of mask (see detail B of Figure 103a)
- E Terminals
- F Movable electrode
- G Base plate

**Figure 103 – Equipment for the spark ignition test**



Detail A – Lower part of mask



Detail B – Upper part of mask

NOTE The mass of the upper part of the mask is approximately 100 g, which is achieved by modifying its thickness

Figure 103a – Details of the mask