

INTERNATIONAL STANDARD



**Household and similar electrical appliances – Safety –
Part 2-96: Particular requirements for flexible sheet heating elements for room
heating**



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IEC 60335-2-96

Edition 3.0 2024-10
COMMENTED VERSION

INTERNATIONAL STANDARD



**Household and similar electrical appliances – Safety –
Part 2-96: Particular requirements for flexible sheet heating elements for room
heating**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 97.100.10, 13.120

ISBN 978-2-8322-0050-6

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

HOUSEHOLD AND SIMILAR ELECTRICAL APPLIANCES – SAFETY –

Part 2-96: Particular requirements for flexible sheet heating elements for room heating

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of 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, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). 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. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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This commented version (CMV) of the official standard IEC 60335-2-96:2024 edition 3.0 allows the user to identify the changes made to the previous IEC 60335-2-96:20019 edition 2.0. Furthermore, comments from IEC TC 61 experts are provided to explain the reasons of the most relevant changes, or to clarify any part of the content.

A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text. Experts' comments are identified by a blue-background number. Mouse over a number to display a pop-up note with the comment.

This publication contains the CMV and the official standard. The full list of comments is available at the end of the CMV.

IEC 60335-2-96 has been prepared by IEC technical committee 61: Safety of household and similar electrical appliances. It is an International Standard.

This third edition cancels and replaces the second edition published in 2019. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) alignment with IEC 60335-1:2020;
- b) conversion of some notes to normative text (Clause 1, 5.2, 7.12.101);
- c) correction to reinstate the touch current limit in 22.105.

The text of this International Standard is based on the following documents:

Draft	Report on voting
61/7279/FDIS	61/7304/RVD

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts of the IEC 60335 series, under the general title: *Household and similar electrical appliances – Safety*, can be found on the IEC website.

This part 2 is to be used in conjunction with the latest edition of IEC 60335-1 and its amendments unless that edition precludes it; in that case, the latest edition that does not preclude it is used. It was established on the basis of the sixth edition (2020) 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: Particular requirements for flexible sheet heating elements for room heating.

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 following additional differences exist in the countries indicated below.

- 1: Flexible sheet heating elements that are cut on site are not allowed (France).
- 7.12.1 c): The instructions in timber floors shall state that the heating unit is to be covered with additional insulation, be supplied through an isolating transformer, or be class II (Sweden).

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

NOTE 4 The attention of National Committees is drawn to the fact that equipment manufacturers and testing organizations can need a transitional period following publication of a new, amended or revised IEC publication in which to make products in accordance with the new requirements and to equip themselves for conducting new or revised tests.

It is the recommendation of the committee that the content of this publication be adopted for implementation nationally not earlier than 12 months or later than 36 months from the date of publication.

IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

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.

Guidance documents concerning the application of the safety requirements for appliances can be accessed via TC 61 supporting documents on the IEC website

<https://www.iec.ch/tc61/supportingdocuments>

This information is given for the convenience of users of this International Standard and does not constitute a replacement for the normative text in this standard.

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 and takes into account the way in which electromagnetic phenomena can affect the safe operation of appliances.

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~~ can 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.

When a part 2 standard does not include additional requirements to cover hazards dealt with in Part 1, Part 1 applies.

NOTE 1 This means that the technical committees responsible for the part 2 standards have determined that it is not necessary to specify particular requirements for the appliance in question over and above the general requirements.

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.

NOTE 2 ~~Horizontal and generic standards~~ Horizontal publications, basic safety publications and group safety publications covering a hazard are not applicable since they have been taken into consideration when developing the general and particular requirements for the IEC 60335 series of standards. ~~For example, in the case of temperature requirements for surfaces on many appliances, generic standards, such as ISO 13732-1 for hot surfaces, are not applicable in addition to Part 1 or part 2 standards.~~ **1**

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 which 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.

NOTE 3 Standards dealing with non-safety aspects of household appliances are:

- IEC standards published by TC 59 concerning methods of measuring performance;
- CISPR 11, CISPR 14-1 and relevant IEC 61000-3 series standards concerning electromagnetic emissions;
- CISPR 14-2 concerning electromagnetic immunity;
- IEC standards published by TC 111 concerning environmental matters. **2**

HOUSEHOLD AND SIMILAR ELECTRICAL APPLIANCES – SAFETY –

Part 2-96: Particular requirements for flexible sheet heating elements for room heating

1 Scope

This clause of Part 1 is replaced by the following.

This part of IEC 60335 deals with the safety of **flexible sheet heating elements** intended to be incorporated into floors and walls below 1,2 m and above 2,3 m and in ceilings, their **rated voltage** being not more than 250 V for single-phase installations and 480 V for other installations including direct current (DC) supplied appliances. **3**

Flexible sheet heating elements are converted into **heating units** that are incorporated in the building in accordance with the instructions after which the required level of protection against hazards is achieved.

NOTE 101—Attention is drawn to the fact that

- in many countries, different wiring rules apply;
- for **heating units** intended to be used in vehicles or on-board ships or aircraft, additional requirements can be necessary;
- in many countries, additional requirements are specified by the national authorities for fire protection, the national authorities for building regulations, the national health authorities, the national authorities responsible for the protection of labour and similar authorities.

NOTE 102—This standard does not apply to

- **heating units** intended exclusively for industrial purposes;
- **heating units** intended to be used in locations where special conditions prevail, such as the presence of a corrosive or explosive atmosphere (dust, vapour or gas);
- blankets, pads, clothing and similar flexible heating appliances (IEC 60335-2-17);
- foot warmers and heating mats (IEC 60335-2-81);
- heated carpets and for heating units for room heating installed under removable floor coverings (IEC 60335-2-106);
- **flexible sheet heating elements** incorporated in other appliances.

2 Normative references

This clause of Part 1 is applicable except as follows.

Addition:

IEC 60364-7-701:~~2006~~, *Low-voltage electrical installations – Part 7-701: Requirements for special installations or locations – Locations containing a bath or shower*

IEC 60884-1:~~2002~~2022, *Plugs and socket-outlets for household and similar purposes – Part 1: General requirements*

~~IEC 60884-1:2002/AMD1:2006~~
~~IEC 60884-1:2002/AMD2:2013⁴~~

ISO 3864-1, *Graphical symbols – Safety colours and safety signs – Part 1: Design principles for safety signs and safety markings*

3 Terms and definitions

This clause of Part 1 is applicable except as follows.

3.1 Definitions relating to physical characteristics

~~Replacement:~~

3.1.9 *Modification:* **4** **normal operation**

Replace the first paragraph with the following:

operation of the **heating unit** after incorporation into the building in accordance with the instructions.

Flexible sheet heating elements, the current of which can vary depending on the length of the **flexible sheet heating elements** and those that can supply other **flexible sheet heating elements** are loaded so that the current marked on the **flexible sheet heating elements** flows through the **heating unit**.

Heating units for **storage heating applications** are charged for 75 % of the **rated charging period**.

3.1.101 **rated charging period**

longest uninterrupted charging period assigned to the **heating unit** by the manufacturer

3.2 Definitions relating to means of connection

3.2.1 *Replacement:* **supply leads**

set of wires intended for connecting the appliance to fixed wiring

3.5 Definitions relating to types of appliances

3.5.4 *Addition:*

Note 101 to entry: **Heating units** are considered to be **fixed appliances**.

3.5.101 **flexible sheet heating element**

heating element consisting of sheets of electrical insulation laminated with electrical resistance material, or a base material on which electrically insulated heating wires are fixed

Note 1 to entry: This definition does not preclude other methods of combining the insulation and resistance materials.

⁴ ~~There exists a consolidated edition 3.2:2013 that includes edition 3:2002, its Amendment 1:2006 and Amendment 2:2013.~~

3.5.102

heating unit

flexible sheet heating element equipped with means of connection to the supply and with insulation surrounding **live parts**

Note 1 to entry: The **heating unit** can be partly or completely prefabricated.

3.5.103

modular heating unit

prefabricated assembly consisting of a **heating unit** and other materials to form a rigid construction for mounting on a ceiling

3.5.104

storage heating application

use of **heating units** to heat thermal accumulating material

Note 1 to entry: The heat is discharged naturally, the heat output being varied by adjusting the energy input.

3.6 Definitions relating to parts of an appliance

3.6.101

electrode

conductive part incorporated in a **flexible sheet heating element** for supplying the heating material

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 Replacement:

In general, eight samples are required for the tests.

The tests of 13.3 and of Clause 15 and Clause 16 are carried out on one sample.

The tests of 18.101 and of Clause 30 are carried out on one sample.

The test of 21.102 is carried out on two samples. One of these samples is also used for the test of 22.101.

The test of 22.103 is carried out on one sample.

The remaining tests are carried out on the sixth sample. The other two samples are required for incorporating into the test arrangement to create the necessary thermal environment.

~~NOTE 101—Additional samples can be necessary if tests have to be repeated.~~

*Nine samples of **modular heating units** are necessary for the tests of 11.2.102.*

Additional samples are necessary if the tests of 18.102 are carried out.

~~Additional samples can be necessary for testing different sizes of **heating units**.~~

The test of 22.105 is carried out on the same sample as that used for the test of 13.2.

Two samples of the additional layer of material, of ~~sufficient~~ a size necessary to cover the heating unit, are required if the test of 21.104 is carried out.

NOTE 101 Additional samples can be necessary if tests have to be repeated or for testing different sizes of heating units.

5.3 Addition:

The test of 22.105 is carried out after the test of 13.2.

5.6 Addition:

Thermostats sensitive to room air temperature or outdoor air temperature are short circuited. However, the thermostat is not short circuited if it can be set so that it does not cycle.

5.10 Addition:

However, for flexible sheet heating elements that are cut on site, the tests are carried out after connecting the supply leads and protecting the edges in accordance with the instructions.

5.101 Heating units intended to be installed in walls above a height of 2,3 m are subjected to the tests for installation in ceilings.

6 Classification

This clause of Part 1 is applicable except as follows.

6.1 Addition:

It is not necessary to classify heating units ~~need not be classified~~. However, if a heating unit is classified, the relevant requirements apply.

6.2 Addition:

Heating units for installation in concrete or similar materials shall be at least IPX7.

Other **heating units** shall be at least IPX1.

7 Marking and instructions

This clause of Part 1 is applicable except as follows.

7.1 Modification:

Instead of the marking of **rated power input** or **rated current** the following applies:

- **heating units** shall be marked with their **rated power input**;
- **flexible sheet heating elements** without connection between adjacent elements shall be individually marked with their **rated power input**;
- other **flexible sheet heating elements** shall be marked with their **rated power input** per metre length.

Flexible sheet heating elements shall be marked with their maximum current if

- the current can vary depending on the length of the **flexible sheet heating element**;
- other **flexible sheet heating elements** can be supplied through them.

Addition:

Flexible sheet heating elements shall be marked with:

- the indication of orientation, unless **heating units** are symmetrical;
- the intended installation (ceilings, walls between 0,2 m and 1,2 m and/or above 2,3 m, or floors);
- the heating mode (direct heating or storage heating), unless intended for both modes.

If the **heating unit** is only intended for application in floors of concrete or similar materials, it shall be marked with the symbol for installation in concrete or similar materials.

The marking shall be repeated at least once every 0,5 m of the **flexible sheet heating element** or on every section that can be cut to form a **heating unit**.

Flexible sheet heating elements that can be cut on site and have to be cut at specified places shall be marked appropriately.

Appliances with separate controls, without a control, or with **detachable controls** shall be marked with the reference number or by other means of identification of the control.

7.6 Addition:



[symbol IEC 60417-6447
(2021-01)]

heating, direct ceiling ~~heating~~



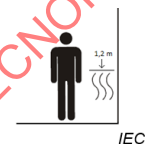
[symbol IEC 60417-6446
(2021-01)]

heating, direct floor ~~heating~~



[symbol IEC 60417-6448
(2021-01)]

heating, floor storage ~~heating~~



[symbol IEC 60417-6445
(2021-01)]

~~wall~~ heating, wall



[symbol IEC 60417-6449
(2021-01)]

heating, installation in concrete
or similar materials

These symbols are information signs and, except for the colours, the rules of ISO 3864-1 apply.

7.12.1 Addition:

Instructions shall be provided. They shall include

- a) explanation of the marking and symbols, if necessary;
- b) information for incorporating the **heating units** into the building, in particular the following:
 - precautions to be taken to avoid damage during installation, such as dropping sharp objects or stepping on the **heating unit**, or careless pouring of concrete;
 - dimensions and distances to be taken into account;
 - a statement that the **heating units** have to be separated from other heat sources such as luminaires and chimneys;
 - description of the fixing areas of the **heating unit** and the separate screen, if applicable;
 - guidance on how to avoid air gaps between the **flexible sheet heating element** and the screed of concrete floors;
 - guidance on how to avoid damage to a **flexible sheet heating element** and its terminations in timber constructions due to relative movement after installation;
 - the lowest ambient temperature at which **heating units** ~~may be installed~~ are recommended for installation;
 - the minimum radius for bending the **flexible sheet heating element**, if applicable;
 - a statement that **heating units** ~~shall~~ are not ~~cross~~ to be installed across expansion joints of the building or structure;
 - a statement to ensure that attachment of room fittings does not restrict heat emission from heated areas.

Except for **modular heating units**, the instructions shall include the following:

- precautions to be taken to avoid creasing the **flexible sheet heating element**;
- a statement that the **heating unit** is not to be installed on irregular surfaces;
- a description of the intended orientation and a statement that the **heating unit** is to be installed in this way (for **heating units** having non-symmetric construction);
- c) a statement that ~~the installation is to be in accordance with the national wiring rules. The substance of the following information shall be included~~ national wiring rules can apply for the installation including the following:
 - a statement that the **heating units** are to be supplied through a residual current device (RCD) having a rated residual operating current not exceeding 30 mA. The RCD shall not be of the time delayed type. Alternatively, except for installations in floors surrounding swimming pools or walls below a height of 2,3 m, they may be supplied through an isolating transformer. This statement is not required for **class III heating units** and for applications in
 - timber floors provided that the instructions for installation state that there is to be an air gap between the heating unit and the floor;
 - timber ceilings;
 - floors of concrete or similar materials in dry locations (dry locations are areas outside zone 3 as defined in IEC 60364-7-701) as long as the **basic insulation** and additional electrical insulation each withstand the electric strength test of 16.3 for **reinforced insulation**;
 - how to connect **heating units** to the supply, giving the cross-sectional area of the leads, if applicable;
 - how to interconnect the **heating units**, giving the cross-sectional area of the leads, if applicable;
 - a statement that **heating units** shall be installed to avoid increasing the ambient temperature of any existing electrical installation;

- d) the maximum current allowed to flow through one **heating unit** when other units are supplied through it or when the current can vary depending on its length;
- e) list of controls, unless they are incorporated into the **heating unit**;
- f) the maximum thermal resistance between the **heating unit** and the room;
- g) the type of covering materials that are allowed to be used in conjunction with the **heating units** with a statement that the advice of the manufacturer is to be requested before materials other than those recommended are used; the thickness of covering materials, which for floors shall be at least 5 mm;
- h) characteristics of the thermal insulation that is to be inserted between separate **heating units** installed to heat a floor and the ceiling below it;
- i) characteristics of the thermal insulation that is to be inserted between separate **heating units** installed to heat both sides of a wall;
- j) specification of any adhesive to be used;
- k) a statement that a label is to be fixed adjacent to the distribution board and that it has to contain the locations of the **heating units**;
- l) if the **heating units** are installed in a suspended ceiling, or are accessible from the roof space, a statement that a label giving this information is to be fixed to the access point of the ceiling;
- m) in applications in timber floors, a statement indicating that **heating units** having **basic insulation** only shall be covered by additional electrical insulation or supplied through an isolating transformer.

NOTE 101 A summary of particular installation requirements for different applications is given in informative Annex AA.

7.12.101 The instructions for applications in floors of concrete or similar materials, including concrete or similar materials laid on a timber floor, or under tiles shall state that

- a) a grid is to be installed above the **heating unit**. The grid is to
 - be protected against corrosion but not electrically insulated;
 - be electrically and mechanically equivalent to a steel grid having a mesh not more than 50 mm × 50 mm and a wire diameter of 1 mm, unless the grid covers
 - **class II heating units**;
 - **heating units** installed with additional electrical insulation;
 - fully cover the **heating unit** including the fixing areas. It ~~may~~ can cover several **heating units**;
 - be connected to earth;
 - be fitted with terminals suitable for the connection of two conductors each having a nominal cross-sectional area of 2,5 mm²;
 - be checked for electrical continuity during installation.

The grid is not required for

- **class III heating units**;
- **class II heating units** supplied through an isolating transformer;
- **class II heating units** that are installed in dry locations (dry locations are areas outside zone 3 as defined in IEC 60364-7-701) and are supplied through a residual current device (RCD);
- **heating units** installed in dry locations (dry locations are areas outside zone 3 as defined in IEC 60364-7-701) if the **basic insulation** and additional electrical insulation each withstand the electric strength test of 16.3 of **reinforced insulation**;
- **heating units** incorporating a metallic shield or braid having a resistance per unit length equivalent to that of 0,5 mm² copper wire;

- b) when the **heating units** have been positioned, they must be covered with an additional layer of material for mechanical protection. If the **heating units** are placed on concrete, a similar layer is to be inserted between the **heating unit** and the concrete. Adjacent layers are to overlap and be fixed to each other. The layer is to extend up each wall to the surface level of the screed. These statements are not required if
 - screened insulated heating wires are covered with a sheath complying with 21.103;
 - the additional electrical insulation complies with the test of 21.102;
- c) when **heating units** having **basic insulation** only, other than those supplied at **safety extra-low voltage**, are provided with additional electrical insulation, this additional insulation is to be placed directly on the **heating unit**;
- d) **class II heating units** are to be installed at a distance of at least 30 mm from conductive parts of the building, such as water pipes.

~~NOTE These instructions apply to applications where the concrete or similar material is laid on a timber floor.~~

7.12.102 The instructions for applications in metallic ceilings or metallic floors for **heating units** with **basic insulation** only, other than those supplied at **safety extra-low voltage**, shall state that

- a) the **flexible sheet heating element** is to be fully covered by the ceiling or floor;
- b) the metallic parts of the ceiling or floor are to be earthed. The instructions shall state that they have to be fitted with terminals suitable for the connection of two conductors each having a nominal cross-sectional area of 2,5 mm² and explain how the connection to the earthing terminal is to be made to ensure a low resistance. The statements regarding the need for earthing are not required if it is stated that a layer of additional electrical insulation is to be installed between the **heating unit** and the ceiling. If this insulation is not provided, the name of the manufacturer and reference of the insulation shall be given.

7.12.103 The instructions for applications on floors where the **heating units** are to be covered by tiles shall state that the **heating units** are to be covered by additional electrical insulation, unless the **heating units** are **class I**, **class II** or **class III**.

7.12.104 The instructions for **flexible sheet heating elements** that can be cut on site shall state that this work is only to be carried out by persons authorized by the manufacturer and shall give information on how to

- cut the flexible sheet heating elements;
- protect the edges of the **flexible sheet heating elements**;
- connect the **supply leads** ~~and~~ to the interconnection leads and insulate the connections.

7.12.105 The instructions for **heating units** for **storage heating applications** shall specify the **rated charging period**.

7.12.106 Unless **heating units**

- incorporate a metallic shield or braid having a resistance per unit length equivalent to that of 0,5 mm² copper wire; or
- are of **class III**; or
- consist of a base material on which metallically screened electrically insulated heating wires are fixed and are for application in walls below a height of 1,2 m,

their instructions shall state that the **heating units** shall be of the type constructed with an electrical conductive screen. The **heating unit** shall be installed so that the screen is towards the covering material.

The instructions for **heating units** which are for application in walls below a height of 1,2 m and with a separate electrical conductive screen shall state that the screen shall be placed between the covering material and the **heating unit**.

The instructions for **heating units** which are for application in walls, shall state that the **heating unit** shall be installed:

- between 0,2 m and 1,2 m above the floor; or
- above 2,3 m above the floor.

The instructions for **heating units** which are for application in walls, shall include the substance of the following:

- the screen is to be connected to the earthing conductor of the fixed installation;
- if the heating unit is installed in an internal wall with the distance between the wall materials less than 50 mm, the heating unit shall be installed so that the screen is towards the wall covering material on both sides of the heating unit.

The instructions for **heating units** with **detachable protection circuit** shall give instructions for their installation.

7.14 Modification:

The test with petroleum spirit is not carried out.

Addition:

If symbols are used relating to the intended installation or heating mode, the superimposed rectangle shall have a height of at least 15 mm.

7.15 Modification:

Only the requirements for switches and controls are applicable.

7.101 A label that contains ~~sufficient~~ space for the locations of the **heating units** to be listed by the installer shall be provided for each installation giving

- the name, trademark or identification mark of the manufacturer or responsible vendor;
- the model or type reference.

It shall state the substance of the following:

- flexible sheet heating units are installed in the ceiling~~/~~, wall~~/~~, or floor, as applicable;
- do not restrict the thermal emission of the heated ceiling~~/~~, wall~~/~~ or floor, as applicable;
- do not affix materials other than those recommended;
- do not insert nails, screws and do not drill in other than heating free areas;
- this label shall be fixed to or adjacent to the distribution board that supplies the heating unit.

If **heating units** are installed in walls below a height of 1,2 m, the label shall state the locations of the heating free areas or heated areas.

Compliance is checked by inspection.

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 except as follows.

10.1 Addition:

The requirement also applies to the **rated power input** per metre length of **flexible sheet heating elements**.

11 Heating

This clause of Part 1 is applicable except as follows.

11.1 Addition:

The tests are carried out in a room that is maintained at an ambient temperature of $20\text{ °C} \pm 2\text{ °C}$.

11.2 Replacement:

Heating units intended to be installed in ceilings are positioned in accordance with 11.2.101.

Modular heating units for suspended ceilings are positioned in accordance with 11.2.102.

Heating units intended to be installed in floors are positioned in accordance with 11.2.103.

Separate **heating units** intended to heat a timber floor and the ceiling below it are positioned in accordance with 11.2.104.

Heating units intended to be installed in timber walls below 1,2 m are positioned in accordance with 11.2.105.

Separate **heating units** intended to heat both sides of a timber wall are positioned in accordance with 11.2.106.

Heating units intended to be installed in walls or against walls of concrete or similar materials are positioned in accordance with 11.2.107.

*If a **heating unit** is provided with a **thermostat** having a separate sensor, the sensor is located on the centre line of one of the adjacent **heating units** but at a minimum of 0,3 m outside the area of the thermal insulation placed on the floor and at a minimum 0,3 m from the edge of the heated area.*

11.2.101 Heating units intended to be installed in a timber ceiling are placed in a test framework, as shown in Figure 101. An area of at least 4 m^2 having a shorter dimension not less than 2 m is covered by at least three **heating units**, the unit under test being placed in the middle. The **heating units** are installed in accordance with the instructions, attention being paid to where they can be located under parts of timber structures such as cross-members. The upper side of the **heating units** is fully covered by a layer of thermal insulation having a thermal resistance of approximately $5\text{ m}^2\text{K/W}$. The underside of the **heating units** is covered with the most unfavourable material listed in the instructions.

The test framework is suspended so that there is a space having a height of approximately 0,3 m above its upper surface and at least 1,5 m below the lower surface. The test framework is surrounded by wooden boards extending approximately 0,2 m below its lower surface.

If the instruction for installation allows the use of gypsum boards as a covering material, an additional test is carried out using this material.

Heating units intended to be installed in a metallic ceiling are installed in accordance with the instructions.

11.2.102 Nine **modular heating units** are installed in accordance with the instructions. They are arranged in a three-by-three matrix, the **heating unit** under test being located in the centre as shown in Figure 102. However, if a dimension of the matrix is less than 1,8 m, additional **heating units** are installed. The upper surface of the matrix is fully covered with a layer of thermal insulation so that the total thermal resistance above the **flexible sheet heating elements** is approximately $5 \text{ m}^2\text{K/W}$. The insulation is positioned so that it is in full contact with the top surfaces of the **heating units**.

The test framework is suspended so that there is a space having a height of approximately 0,3 m above its upper surface and at least 1,5 m below its lower surface. The test framework is surrounded by wooden boards extending approximately 0,2 m below its lower surface and up to the ceiling of the room.

11.2.103 **Heating units** intended to be installed in a timber floor are placed in a test framework, as shown in Figure 103. **Heating units** intended to be installed on top of a timber floor are placed in a test framework as shown in ~~Figure 107~~ Figure 104. An area of at least 4 m^2 having a shorter dimension not less than 2 m is covered by at least three **heating units**, the unit under test being placed in the middle. Thermal insulation having a thermal resistance of approximately $5 \text{ m}^2\text{K/W}$ is located below the **heating units**. The **heating units** are installed in accordance with the instructions for installation, attention being paid to where they can be located over parts of the timber structure such as cross-members. The upper side of the framework is covered with the most unfavourable floor with regard to the total thermal resistance in accordance with the instructions for installation, an air gap being maintained as shown in the figures, if specified in the instructions.

The test framework has a free space of at least 0,1 m below its lower surface and at least 1,5 m above its upper surface. The test framework is surrounded by wooden boards extending at least 1 m above its upper surface.

A piece of thermal insulation having a thermal resistance of approximately $1,25 \text{ m}^2\text{K/W}$ is placed on the floor centrally across the **heating units**, as shown in Figure 103 and ~~Figure 107~~ Figure 104. The insulation has a length of 0,8 m and a width equal to that of the **heating unit**.

Heating units intended to be installed in a floor of concrete or similar materials are placed as shown in ~~Figure 104~~ Figure 105. **Heating units** intended to be installed above a floor of concrete or similar materials are placed as shown in ~~Figure 108~~ Figure 106. **Heating units** are installed in accordance with the instructions for installation, any specified additional electrical insulation being placed over them. An area of at least 4 m^2 , having a shorter dimension not less than 2 m, is covered by at least three **heating units**, the unit under test being placed in the middle. Thermal insulation having a thermal resistance of approximately $2,5 \text{ m}^2\text{K/W}$ is located underneath the **heating units**. For **heating units** intended to be installed in concrete or similar materials, the thermal insulation is supported by a dull black painted plywood board approximately 20 mm thick.

The **heating units** are covered with the additional layer, if specified in the instructions. They are then covered with a layer of concrete approximately 40 mm thick or the thickness stated in the instructions, whichever is greater. Instead of pouring concrete, the concrete layer may consist of concrete slabs 40 mm thick and having dimensions at least 500 mm × 500 mm, the gaps between the slabs being filled with dry sand. If the **heating unit** is intended for a **storage heating application**, the thickness of the concrete is increased to 80 mm. The concrete layer is not included for **heating units** intended to be installed on top of a concrete floor. A grid is included in the test arrangement if specified. The floor is covered with the most unfavourable flooring material listed in the instructions for installation. There is a free space of at least 1,5 m above the floor.

Thermal insulation may be used instead to represent the most unfavourable flooring material.

A piece of thermal insulation having a thermal resistance of approximately 1,25 m²K/W is placed on the floor centrally across the **heating units**, as shown in ~~Figures 104 and 108~~ Figure 105 and Figure 106. The insulation has a length of 0,8 m and a width equal to that of the **heating unit**.

Part of the thickness of concrete may be replaced by sand provided that the thermal resistance is maintained.

Care shall be taken to minimize air gaps in the floor and between the slabs of concrete.

In order to measure the highest temperature rise of the floor, it ~~may~~ can be necessary to repeat the test with the covering material having the minimum thickness specified in the instructions.

Heating units intended to be installed in metallic floors are installed in accordance with the instructions.

11.2.104 Separate **heating units** intended to heat a timber floor and the ceiling below it are installed in a test framework shown in ~~Figure 105~~ Figure 107 in accordance with the instructions. An area of at least 4 m² having a shorter dimension not less than 2,0 m is covered by two sets of at least three **heating units** separated by thermal insulation. The **heating units** under test are placed in the middle, one over the other. The insulation has a thermal resistance of approximately 1,45 m²K/W unless a lower value is specified in the instructions. The other details for the arrangement are as specified in 11.2.101 and 11.2.103 for timber constructions.

11.2.105 **Heating units** intended to be installed in timber walls below 1,2 m are placed in a test framework, as shown in ~~Figure 110~~ Figure 108. An area of at least 4 m² having a shorter dimension not less than 2 m is covered by at least three **heating units**, the unit under test being placed in the middle. The **heating units** are installed in accordance with the instructions, attention being paid to where they can be located under parts of timber structures such as cross-members.

The side, towards the room to be heated, of the **heating units** is covered with the most unfavourable covering material listed in the instructions. The side without the **heating units** is fully covered by a layer of thermal insulation having a thermal resistance of approximately 5 m² K/W and which is held against the **heating unit** according to the instructions for installation.

Covering material is added even to the side of the wall without the **heating units**. No air gap is to be left between the covering material and the thermal insulation.

The test framework is situated so that there is a space having a width of approximately 0,3 m from its unheated surface and at least 1,5 m from the surface to be heated. The test framework is surrounded by wooden boards extending approximately 0,2 m from the covering material.

A piece of thermal insulation having a thermal resistance of approximately $1,25 \text{ m}^2 \text{ K/W}$ is placed against the wall towards the room centrally across the **heating units**, as shown in ~~Figure 110~~ Figure 108. The insulation has a length of 0,8 m and a width equal to that of the **heating unit**.

If the instruction for installation allows the use of gypsum boards as a covering material, an additional test is carried out using this material.

Heating units intended to be installed in a metallic wall are installed in accordance with the instructions.

11.2.106 Separate **heating units** intended to heat a timber wall on both sides are installed in a test framework shown in ~~Figure 111~~ Figure 109 in accordance with the instructions. An area of at least 4 m^2 having a shorter dimension not less than 2,0 m is covered by two sets of at least three **heating units** separated by a thermal insulation. The **heating units** under test are placed in the middle, one opposite the other. The insulation has a thermal resistance of approximately $1,45 \text{ m}^2 \text{ K/W}$ unless a lower value is specified in the instructions. The test framework is surrounded by wooden boards extending approximately 0,2 m from the covering material. The other details for the arrangement are as specified in 11.2.101 and 11.2.103 for timber constructions.

A piece of thermal insulation having a thermal resistance of approximately $0,9 \text{ m}^2 \text{ K/W}$ is placed against one of the walls centrally across the **heating units**, as shown in ~~Figure 111~~ Figure 109. The insulation has a length of 0,8 m and a width equal to that of the **heating unit**.

11.2.107 **Heating units** intended to be installed in a wall of concrete or similar materials are placed as shown in ~~Figure 112~~ Figure 110. **Heating units** intended to be installed against a wall of concrete or similar materials are placed as shown in ~~Figure 113~~ Figure 111. **Heating units** are installed in accordance with the instructions for installation, any specified additional electrical insulation being placed against them. An area of at least 4 m^2 , having a shorter dimension not less than 2 m, is covered by at least three **heating units**, the unit under test being placed in the middle. Thermal insulation having a thermal resistance of approximately $2,5 \text{ m}^2 \text{ K/W}$ is located on the back side of the **heating units**. For **heating units** intended to be installed in concrete or similar materials, the thermal insulation is supported by a dull black painted plywood board approximately 20 mm thick.

The **heating units** are covered with the additional layer, if specified in the instructions. They are then covered with a layer of concrete approximately 40 mm thick or the thickness stated in the instructions, whichever is greater. Instead of pouring concrete, the concrete layer may consist of concrete slabs 40 mm thick and having dimensions at least $500 \text{ mm} \times 500 \text{ mm}$, the gaps between the slabs being filled with fine grain concrete. If the **heating unit** is intended for a **storage heating application**, the thickness of the concrete is increased to 80 mm. The concrete layer is not included for **heating units** intended to be installed against a concrete wall. A grid is included in the test arrangement if specified. The wall is covered with the most unfavourable covering material listed in the instructions for installation. There is a free space of at least 1,5 m from the wall. The test framework is surrounded by wooden boards extending approximately 0,2 m from the covering material.

Care shall be taken to minimize air gaps in the wall and between the slabs of concrete.

11.7 ~~Replacement~~ Modification: 5

Replace the first paragraph with the following:

Heating units are operated until steady conditions are established.

Heating units for **storage heating applications** are operated as specified for **normal operation** or until the charging control operates for the first time if this occurs first.

11.8 Addition:

The temperature rise of surfaces shall not exceed the values shown in Table 101.

Table 101 – Temperature rise limits for surfaces

Part	Temperature rise K
Floor surface, 5 cm outside the edge of the piece of thermal insulation	22 ^a
Wood of the test framework	60
Surface of the flexible sheet heating element and additional electrical insulation ^b	–
^a For storage heating applications , the temperature rise may be up to 4 K higher for a period not exceeding 3 h. ^b No temperature rise limit is specified. However, the temperature has to be determined in order that other tests of the standard can be carried out.	

12 ~~Void~~ Charging of metal-ion batteries

This clause of Part 1 is applicable. **6**

13 Leakage current and electric strength at operating temperature

This clause of Part 1 is applicable except as follows.

13.1 Addition:

The **heating units** are installed as specified in 11.2, the most unfavourable covering material with respect to its electrical insulation characteristics being used.

The concrete shall be fully dry before the test.

13.2 Addition:

The value specified for **class 0 appliances** applies to **heating units** having **basic insulation** only.

The value specified for **class II appliances** applies to **heating units** intended to be installed on a conductive surface and those covered by concrete or similar materials.

If the **heating unit** is intended to be installed on a conductive surface or covered by concrete or similar materials, any additional electrical insulation specified in the instructions is placed in position.

Grids and screens of insulated heating wires are disconnected from earth.

The metal foil is placed on **accessible surfaces**. It is connected to the metal support of the test arrangement when testing **modular heating units**. The metal foil is not brought into contact with the terminations of grids or screens of insulated heating wires.

13.3 Modification:

*The test is carried out directly on a **heating unit** and additional electrical insulation. The test voltage is applied after they have been conditioned for a period of 1 h at the temperature determined during the test of Clause 11.*

14 Transient overvoltages

This clause of Part 1 is applicable.

15 Moisture resistance

This clause of Part 1 is applicable except as follows.

15.1 Addition:

*The test is carried out directly on a **heating unit**.*

15.1.1 Addition:

*IPX7 **heating units** are immersed for 72 h.*

15.1.2 Replacement:

***Heating units**, other than IPX7 **heating units**, are placed horizontally on a perforated support in accordance with IEC 60529, taking into account the marking of orientation. If the orientation is not marked, they are tested in both positions.*

15.3 Modification:

*The test is carried out directly on a **heating unit** and additional electrical insulation.*

16 Leakage current and electric strength

This clause of Part 1 is applicable except as follows.

16.1 Modification:

*The tests are carried out directly on a **heating unit** and additional electrical insulation.*

16.2 Addition:

*The value specified for **class 0 appliances** applies to **heating units** with **basic insulation** only.*

*The value specified for **class II appliances** applies to **heating units** intended to be installed on a conductive surface or covered by concrete or similar materials.*

*If the **heating unit** is intended to be installed on a conductive surface or covered by concrete or similar materials, any electrical insulation specified in the instructions is placed in position.*

16.3 Addition:

*The values specified for **class 0 appliances** apply to **heating units** with **basic insulation** only.*

The values specified for **class II appliances** apply to **heating units** intended to be installed on a conductive surface or covered by concrete or similar materials.

If the **heating unit** is intended to be installed on a conductive surface or covered by concrete or similar materials, any electrical insulation specified in the instructions is placed in position.

For **heating units** with **basic insulation** only, other than those supplied at **safety extra-low voltage**, that are provided with additional electrical insulation for application in floors of concrete or similar materials, each insulation shall withstand the test voltage specified for **reinforced insulation**.

For **heating units** with **basic insulation** only, other than those supplied at **safety extra-low voltage**, that are provided with additional electrical insulation for application in metallic ceilings, this additional insulation shall withstand the test voltage specified for **supplementary insulation**.

For **heating units** with **basic insulation** only, other than those supplied through an isolating transformer, that are provided with additional electrical insulation for application in timber floors, this additional insulation shall withstand the test voltage specified for **supplementary insulation**.

17 Overload protection of transformers and associated circuits

This clause of Part 1 is applicable.

18 Endurance

This clause of Part 1 is applicable except as follows.

18.101 The connections from the **flexible sheet heating element** to the **supply leads** and to interconnection leads shall be reliable.

Compliance is checked by the following test.

The **heating unit** is placed in a heating cabinet at a temperature of $20\text{ °C} \pm 2\text{ °C}$ and is supplied with a voltage so that the current is equal to the value marked on the **flexible sheet heating element** or to the **rated current**, as applicable. The voltage drop at each connection is measured.

The length of the **heating unit** shall be as short as possible but not less than 0,5 m. The **heating unit** is not moved after it has been placed in the cabinet.

If the connections are made by using crimp connectors, the voltage drop measurement is carried out between the **supply lead** and the connector as well as between the connector and the **flexible sheet heating element**. The measuring points are as close as possible to the connections.

The **heating unit** is heated in cycles. Each cycle has a duration of 1 h and comprises

- a period of 30 min, during which
 - the **heating unit** is supplied with the voltage that was applied when the voltage drop was measured;
 - for the first 20 min, the temperature of the heating cabinet is raised to 85 °C or to the temperature of the **flexible sheet heating element** determined during the test of Clause 11, whichever is lower;

- for the last 10 min, the temperature of the heating cabinet is maintained within ± 5 K of this temperature;
- a period of 20 min, during which the temperature is lowered to approximately 30 °C;
- a stabilization period of 10 min.

The temperature in the heating cabinet is measured at a distance of at least 50 mm from the **heating unit**. Forced cooling may be used.

The test is carried out for 400 cycles. The temperature of the heating cabinet is then reduced to 20 °C $\pm$ 2 °C and the voltage drop at each connection is measured again.

The voltage drop shall not exceed 22,5 mV or 1,5 times the first value measured, whichever is lower.

After the test, inspection shall show no damage to the extent that compliance with this standard is impaired.

18.102 The electrical connections between the resistance material and **electrodes of flexible sheet heating elements** shall be reliable.

Compliance is checked by tests that are carried out on two **heating units**, each having a length exceeding 1 m.

One **heating unit** is subjected to the test of 18.102.2 after which it is subjected to the test of 18.102.5. The other **heating unit** is subjected to the tests of 18.102.1 to 18.102.5.

After the tests, the voltage drop of the second **heating unit**, determined at the location where bending is applied during the tests of 18.102.2, shall not exceed 1,5 times the voltage drop that was determined on the first **heating unit**. In addition, the average voltage drop determined at the other locations of the second **heating unit**, shall not exceed 1,5 times the average voltage drop of the first **heating unit**.

Inspection shall show no contact degradation such as pitting under the **electrodes** or damage adjacent to the **electrodes**.

18.102.1 The **heating unit** is wound on a cylindrical mandrel having a diameter equal to twice the minimum radius for bending the **flexible sheet heating element** specified in the instructions and then unwound. This is repeated with the other face of the **flexible sheet heating element** against the mandrel.

The test is carried out three times.

If the instructions state that the **heating unit** is only to be wound in one direction, the test is carried out six times in this direction.

18.102.2 Part of the **heating unit** is held between two boards 100 mm thick and of ~~sufficient~~ a size *necessary* to fully cover the width of the **flexible sheet heating element**. One pair of edges of the boards is rounded with a radius of 50 mm.

The assembly is placed in an ambient temperature of –5 °C or the lowest ambient temperature specified for installation, whichever is lower. When the **flexible sheet heating element** has reached this temperature, its free end is bent over the rounded edges of the boards. It is bent through an angle of 180° and back to its normal position, in both directions. This bending operation is carried out three times.

18.102.3 The **heating unit** is placed in a humidity cabinet having a relative humidity of $80\% \pm 5\%$ and a temperature of $40\text{ °C} \pm 2\text{ °C}$. It is supplied at **rated voltage** and operated for 1 h after which the supply is switched off for 1 h.

The test is carried out for 1 000 cycles.

18.102.4 The **heating unit** is subjected to the test of 18.101 which is carried out for 2 000 cycles. However, the voltage drop and inspection for damage is not determined.

18.102.5 The **heating unit** is placed on a horizontal surface and supplied at **rated voltage**. A needle is inserted into the resistance material of the **flexible sheet heating element** at an angle of 45 ° and at a distance of 5 mm from the inside edge of the **electrode**.

Any conductive material between the **electrode** and the resistance material is considered to be part of the **electrode**. A jig such as that shown in ~~Figure 106~~ Figure 112 may be used to locate the needle.

The voltage (U_m) between the needle and the supply connection to the **electrode** is measured.

Compensation for the voltage drop in the **electrode** itself is allowed.

The voltage drop (ΔU) at the contact is determined from the following formula:

$$\Delta U = U_m \frac{5U_r}{d}$$

where

U_m is the voltage measured between the needle and the supply connection to the **electrode**;

U_r is the rated voltage of the heating unit;

d is the distance, in millimetres, between the inside edges of the **electrodes**. If the conductive path is not perpendicular to the **electrodes**, the distance is measured along the centreline of the path.

The voltage drop is determined at the location where bending is applied during the test of 18.102.2. It is also determined at not less than six other locations and the average value is calculated.

The location of the test points may be selected with the aid of thermal imaging equipment.

18.103 The resistance of the **heating unit** shall not decrease significantly during use.

Compliance is checked by the following test.

The **heating unit** is placed in a heating cabinet having a temperature 5 K higher than the temperature on the surface of the **flexible sheet heating element** determined during the test of Clause 11.

After a period of 2 h, the resistance of the **heating unit** is measured. The resistance is measured again at intervals not exceeding 72 h. The **heating unit** is left in the heating cabinet for 3 000 h. During the test, the resistance of the **heating unit** shall not decrease by more than 5 % below the value measured after the initial period of 2 h.

19 Abnormal operation

This clause of Part 1 is applicable except as follows.

19.2 Addition:

*For ceiling applications, a piece of thermal insulation having a thermal resistance of approximately $0,9 \text{ m}^2\text{K/W}$ is held against the ceiling covering material and located centrally across the **heating units**. It has a length of $0,8 \text{ m}$ and a width equal to that of the **heating unit**.*

*For wall applications, a piece of thermal insulation having a thermal resistance of approximately $1,45 \text{ m}^2\text{K/W}$ is held against the wall covering material and located centrally across the **heating units**. It has a length of $0,8 \text{ m}$ and a width equal to that of the **heating unit**.*

*For wall applications, if the **heating unit** is intended to be installed on both sides of a wall, a piece of thermal insulation having a resistance of approximately $1,45 \text{ m}^2\text{K/W}$ is held against the wall on both sides and located centrally across the **heating units**. It has a length of $0,8 \text{ m}$ and a width equal to that of the **heating unit**.*

For floor applications, the thermal resistance of the piece of thermal insulation placed on the floor is increased to approximately $1,45 \text{ m}^2\text{K/W}$ and is placed in the most unfavourable position.

*For **storage heating applications**, the **heating units** are charged for the **rated charging period**.*

19.13 Addition:

The temperature rise of the floor and the wood of the test framework shall not exceed 150 K .

20 Stability and mechanical hazards

This clause of Part 1 is not applicable.

21 Mechanical strength

This clause of Part 1 is applicable except as follows.

21.1 Addition:

*The blows are only applied to rigid parts of the **heating unit**.*

***Heating units** are subjected to the tests of 21.101.*

***Heating units** intended to be installed in floors are also subjected to the test of 21.102.*

***Heating units** incorporating insulated wires intended to be installed in floors are also subjected to the test of 21.103.*

*The additional layer of material covering **heating units** in floors of concrete or similar materials, or under tiles, is subjected to the test of 21.104.*

*These tests are not applicable to **modular heating units**.*

21.101 Part of the **flexible sheet heating element** is held between two boards 100 mm thick and of ~~sufficient~~ a size ~~necessary~~ to fully cover the width of the **flexible sheet heating element**. One pair of edges of the boards is rounded with a radius of 50 mm.

The assembly is placed in an ambient temperature of $-5\text{ }^{\circ}\text{C}$ or the lowest ambient temperature specified for installation, whichever is lower. When the **flexible sheet heating element** has reached this temperature, its free end is bent over the rounded edges of the boards. It is bent through an angle of 180° and back to its normal position, in both directions. This bending operation is carried out three times.

The **heating unit** shall then withstand the electric strength test of 16.3 and shall not be damaged to such an extent that compliance with this standard is impaired.

21.102 This test is carried out on two **heating units**. The **heating unit** is placed on a horizontal steel plate having a smooth surface and the surface of the **flexible sheet heating element** is scratched by means of a hardened steel pin, the end of which has the form of a cone with an angle of 40° . Its tip is rounded with a radius of $0,25\text{ mm} \pm 0,02\text{ mm}$. The pin is loaded so that the force exerted along its axis is $10\text{ N} \pm 0,5\text{ N}$ for applications in floors of concrete and similar ~~floors~~ materials and $5\text{ N} \pm 0,5\text{ N}$ for applications in other floors. The scratches are made by drawing the pin along the surface at a speed of approximately 20 mm/s. The pin is held at an angle of 5° to 10° from the vertical in the direction of movement.

Three scratches, at least 50 mm apart, are made on both sides of one **flexible sheet heating element**. They are made parallel with the length of the **heating unit** and at least 10 mm from one of the edges. The length of the scratches is approximately equal to the width of the **heating unit**. If the **flexible sheet heating element** incorporates **electrodes**, one of the scratches is made along one of the **electrodes**.

Two similar scratches are made across the full width on both sides of the other **flexible sheet heating element**.

The **heating unit** shall then withstand the electric strength test of 16.3.

21.103 The part of the **heating unit** containing an insulated heating wire is placed on a rigid steel plate. A steel rod, 6 mm in diameter, is placed across the heating wire so that it is only in contact in one location.

A force is applied to the rod for 30 s and has a value of

- 600 N, for **heating units** for applications in floors of concrete;
- 300 N, for **heating units** for other floor applications.

The force is applied to five different locations at least 50 mm apart.

The **heating unit** shall then withstand the electric strength test of 16.3. If the insulated heating wire contains more than one conductor, the test for **basic insulation** is also carried out between the conductors.

If the **heating unit** contains screened insulated wires covered by a sheath, the test for **basic insulation** is also carried out between the conductors and the screen.

There shall be no penetration of the sheath.

21.104 A sample of the additional layer of material is placed on a horizontal steel plate having a smooth surface and is scratched by means of a hardened steel pin, the end of which has the form of a cone with an angle of 40° . Its tip is rounded with a radius of $0,25\text{ mm} \pm 0,02\text{ mm}$. The pin is loaded so that the force exerted along its axis is $10\text{ N} \pm 0,5\text{ N}$ for applications in floors of concrete and similar ~~floors~~ materials and $5\text{ N} \pm 0,5\text{ N}$ for other applications. The pin is held at

an angle of 80° to 85° to the horizontal and scratches are made by drawing the pin along the surface at a speed of approximately 20 mm/s.

*Three scratches are made at least 50 mm apart. Scratches shall be at least 10 mm from one of the edges. The length of the scratches is approximately equal to the width of the **heating unit**.*

Similar scratches are made on the second sample, but at right angles to the direction of the scratches on the first sample.

There shall be no penetration of the material.

22 Construction

This clause of Part 1 is applicable except as follows.

22.101 The means of connection to the supply shall be securely fixed to the **flexible sheet heating element**.

*Compliance is checked by the following test which is carried out on two **heating units**.*

*The **heating unit** is laid flat on a horizontal surface and held in position so that approximately 100 mm length of **flexible sheet heating element** together with the **supply leads** hang over the edge of the surface. The free length of the **supply leads** is approximately 300 mm.*

*A force of 60 N is applied without jerks to each **supply lead** for 1 min. The test is repeated after a rest period of 1 min.*

*There shall be no damage to the lead, connection or **flexible sheet heating element** impairing compliance with this standard. The **heating unit** shall withstand the electric strength test of 16.3.*

22.102 The insulation covering the connections and the edges of the **flexible sheet heating element** shall not affect the material of the **flexible sheet heating element**.

Compliance is checked by the following test.

*The **heating unit** is placed in a cabinet at a temperature of 80 °C or 45 °C plus the temperature rise determined during the test of Clause 11, whichever is higher. The test is carried out for 336 h.*

*After the **heating unit** has cooled down to ~~approximately~~ **room temperature**, it shall withstand the electric strength test of 16.3.*

22.103 The sheets of electrical insulation of laminated **flexible sheet heating elements** shall be reliably bonded together. However, if the **heating units** are for application in a floor of concrete or similar materials, only the edges of the **flexible sheet heating element** have to be bonded.

Compliance is checked by the following test.

*Two sets of three samples having dimensions of approximately 15 mm × 150 mm are cut from a new **flexible sheet heating element**. The samples for each set are taken from the edge and from the heating surface both perpendicular and parallel to an edge. For applications in floors of concrete or similar materials, the set consists of one sample that is cut from the edges.*

One set is placed for 336 h in a heating cabinet corresponding to the temperature of the **flexible sheet heating element** determined during the test of Clause 11.

The layers of insulation are then separated at one end of each of the samples and attached to the clamps of a tensile machine in turn.

If it is not possible to separate the layers, specially prepared samples may be used.

The clamps are separated at a rate of 250 mm/min $\pm$ 50 mm/min.

The bond strength of each sample shall be at least 1,5 N.

The average bond strength of the conditioned samples shall be not less than 80 % of the average bond strength of the unconditioned samples.

22.104 Connecting devices fitted to **supply leads** and interconnection leads shall be of **class II construction**. It shall not be possible to separate them without the aid of a **tool**.

Compliance is checked by inspection.

22.105 **Heating units** of **class II construction** intended to be installed under floors in damp locations shall not subject the user to excessive capacitive currents.

Heating units having **basic insulation** only, but covered with additional electrical insulation, are considered to be **class II construction**.

Compliance is checked by the following test. However, the test is not carried out if the instructions for installation specify that an air gap is required between the **heating unit** and the floor.

The grid is connected to earth and to a metal foil having an area approximately 200 mm $\times$ 100 mm through the measurement instrument shown in ~~Figure 109~~ Figure 113. The surface of the floor directly above a **heating unit** is covered with 0,25 l of water containing approximately 1 % NaCl and left for 2 h. The metal foil is placed on the wet surface and the **heating units** are supplied at 1,06 times **rated voltage**.

The capacitive current shall not exceed 0,25 mA. **7**

22.106 **Heating units** other than **class III heating units** for wall installations below a height of 1,2 m, shall be fitted with an earthed conductive screen which is laminated with electrical insulation or shall be provided by the manufacturer of the **heating unit** with a separate earthed conductive screen which is laminated with electrical insulation.

The conductive screen shall incorporate a terminal or wire that enables the screen to be connected to the protective conductor of the electrical installation.

The conductive screen shall fully cover the current carrying parts of the **flexible sheet heating element**.

Heating units other than **class III heating units** for wall installations below a height of 1,2 m shall incorporate or be delivered with a protection circuit that disconnects both poles of the supply within one cycle of supply frequency when the **flexible sheet heating element** insulation is penetrated.

The protection circuit shall not automatically reset or automatically reconnect the supply when the penetrating object is removed.

Compliance is checked by inspection and by the test of 22.106.1. Electrically insulated tools shall be used when the voltage is applied to the sample.

22.106.1 The appliance is supplied at **rated voltage**. An attempt is made with a steel pin with a diameter of 1 mm, to touch the **flexible sheet heating element** in three locations. A suitable supporting surface which allows the pin to penetrate through the surface shall be used in order to ensure that the current carrying part of the **flexible sheet heating element** can be touched with the pin.

If contact with the current carrying part of the **flexible sheet heating element** is made, a protection circuit shall operate to give all pole disconnection of the **flexible sheet heating element** within one cycle of the supply frequency.

When the test pin is removed from the contact with the current carrying part of the **flexible sheet heating element**, a manual operation shall be required to re-energize the **flexible sheet heating element**.

If the protection circuit does not rely on a connection to the supply system protective earth to cause its operation,

- the voltage on the test pin prior and during detection shall not be greater than 24 V, and
- the maximum current through the test pin shall not exceed 5 mA, when measured to earth or any of the supply conductors.

If the protection system relies on contact with a conductive layer, such as metal braiding or metal foil, to cause its operation and if the conductive layer does not comply with the requirements for **accessible metal parts** of 27.5, then the conductive layer shall be insulated from **live parts** by **reinforced insulation** or **double insulation** and be covered by a sheath complying with the requirements for **basic insulation**.

23 Internal wiring

This clause of Part 1 is applicable.

24 Components

This clause of Part 1 is applicable except as follows.

24.101 Thermal cut-outs that are necessary for compliance with Clause 19 shall be **non-self-resetting** with a trip-free mechanism.

Compliance is checked by inspection.

24.102 Controls and other components necessary for the **heating unit** to comply with this standard shall be supplied with the **flexible sheet heating element** or ~~sufficiently~~ specified in the instructions for installation so they can be obtained separately.

Controls and other components necessary for the **heating unit** to comply with 22.106 of this standard shall be supplied with the **flexible sheet heating element**.

Compliance is checked by inspection.

25 Supply connection and external flexible cords

This clause of Part 1 is applicable except as follows.

25.3 Replacement:

Heating units, other than those that can be cut on site, shall incorporate one of the following means for permanent connection to fixed wiring:

- a set of terminals, or
- a set of **supply leads**, or
- a **supply cord**.

Heating units that can be cut on site shall be supplied with a suitable means for connection to the supply mains. **Supply leads** shall be double insulated or fitted with insulating sleeves. The sleeves shall be at least 300 mm long and have a thickness corresponding to that of a sheath of a **supply cord** (code designation 60245 IEC 53).

Compliance is checked by inspection.

25.5 Modification:

Type Z attachment is allowed.

26 Terminals for external conductors

This clause of Part 1 is applicable except as follows.

26.1 Addition:

Heating units shall not incorporate screw-type terminals.

26.5 Modification:

This requirement applies to all terminals to which connections are made during installation.

26.11 Addition:

This requirement also applies to **heating units** fitted with **supply leads**.

27 Provision for earthing

This clause of Part 1 is applicable except as follows.

27.1 Addition:

Components provided for the reduction of capacitive currents, and which are earthed, are not considered to provide provision for earthing.

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.

29.1 *Modification:*

Modular heating units are in overvoltage category II. Other **heating units** are in overvoltage category III.

29.3 *Modification:*

There are no dimensional requirements for the insulation of **heating units** or additional electrical insulation.

29.3.2 *Addition:*

*For **class II heating units**, there shall be two layers of insulation on the **flexible sheet heating element** and each of these layers shall withstand the electric strength test of 16.3 for **reinforced insulation**. However, if the layers are inseparable, the combination shall withstand the electric strength test of 16.3 for **reinforced insulation**.*

30 Resistance to heat and fire

This clause of Part 1 is applicable except as follows.

30.1 *Addition:*

*The test is not applicable to **flexible sheet heating elements**.*

The tests of IEC 60884-1:2022, 25.1 and 25.4, are applicable to the flexible parts of connecting devices.

30.2 *Modification:*

The requirement is not applicable to **heating units** intended for applications in concrete or similar materials.

30.2.3.1 *Modification:*

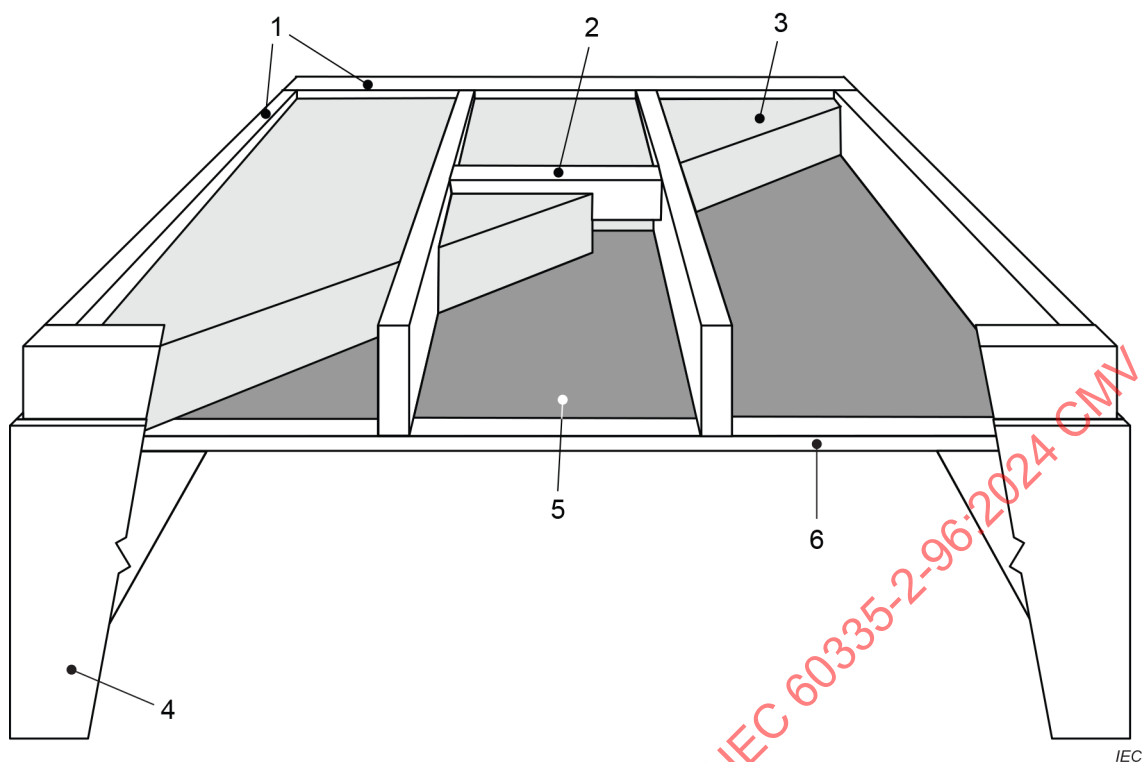
*This subclause is not applicable to **flexible sheet heating elements**.*

31 Resistance to rusting

This clause of Part 1 is applicable.

32 Radiation, toxicity and similar hazards

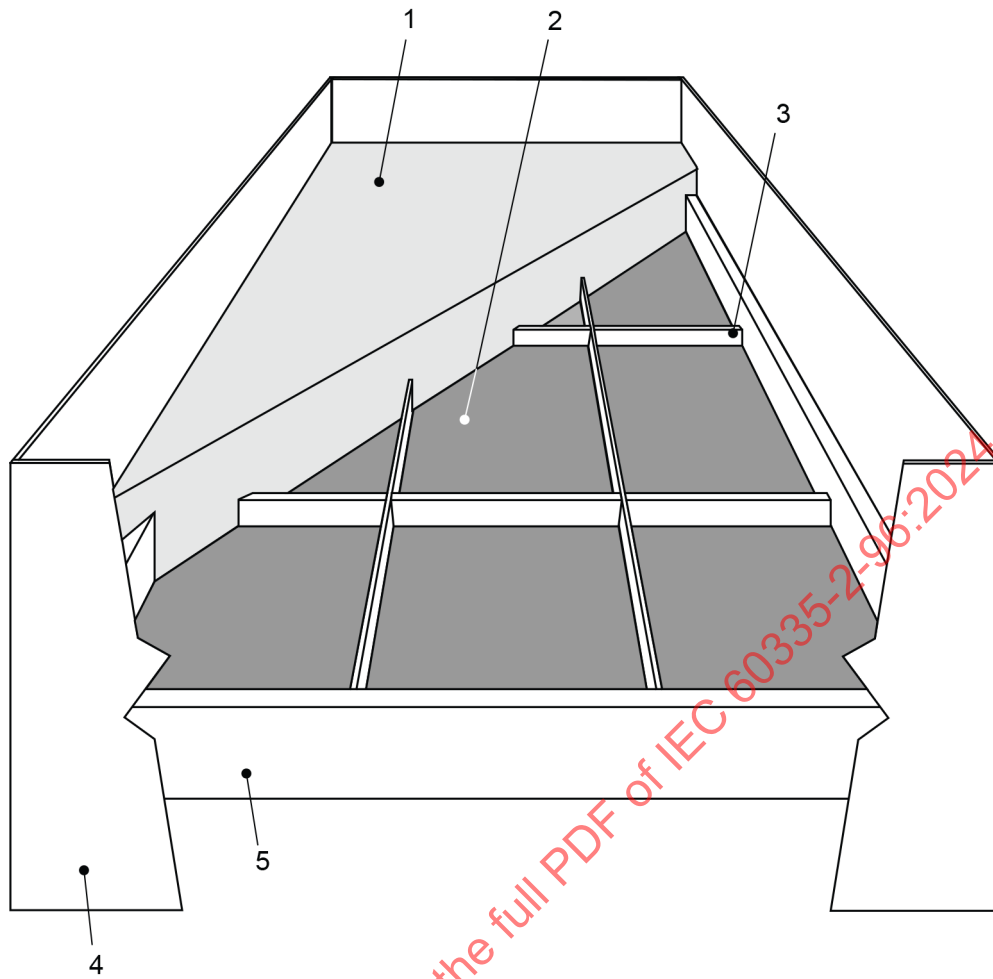
This clause of Part 1 is applicable.



Key

- 1 50 mm × 200 mm timber frame
- 2 cross member
- 3 thermal insulation
- 4 wooden board
- 5 heating unit
- 6 covering material

Figure 101 – Arrangement for testing heating units in timber ceilings

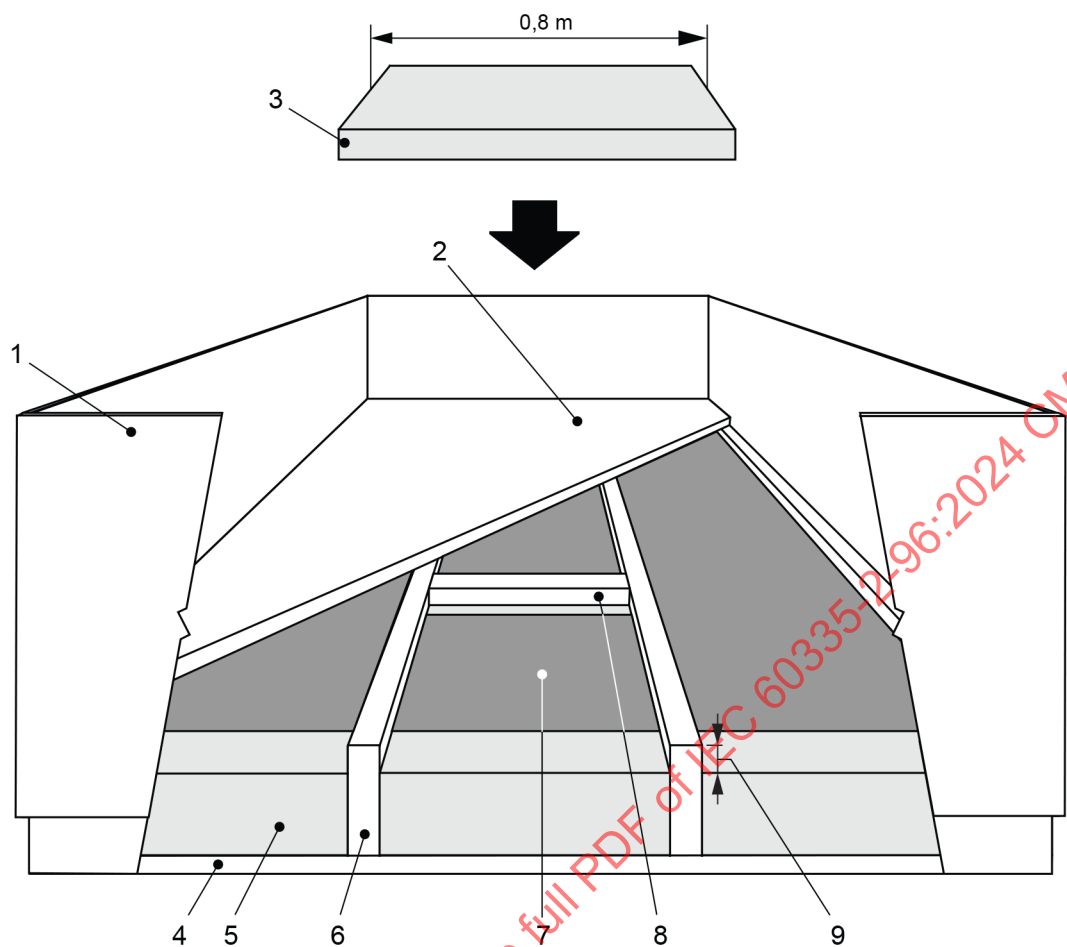


IEC

Key

- 1 thermal insulation
- 2 modular heating unit
- 3 support frame
- 4 wooden board
- 5 50 mm × 200 mm timber frame

Figure 102 – Arrangement for testing modular heating units

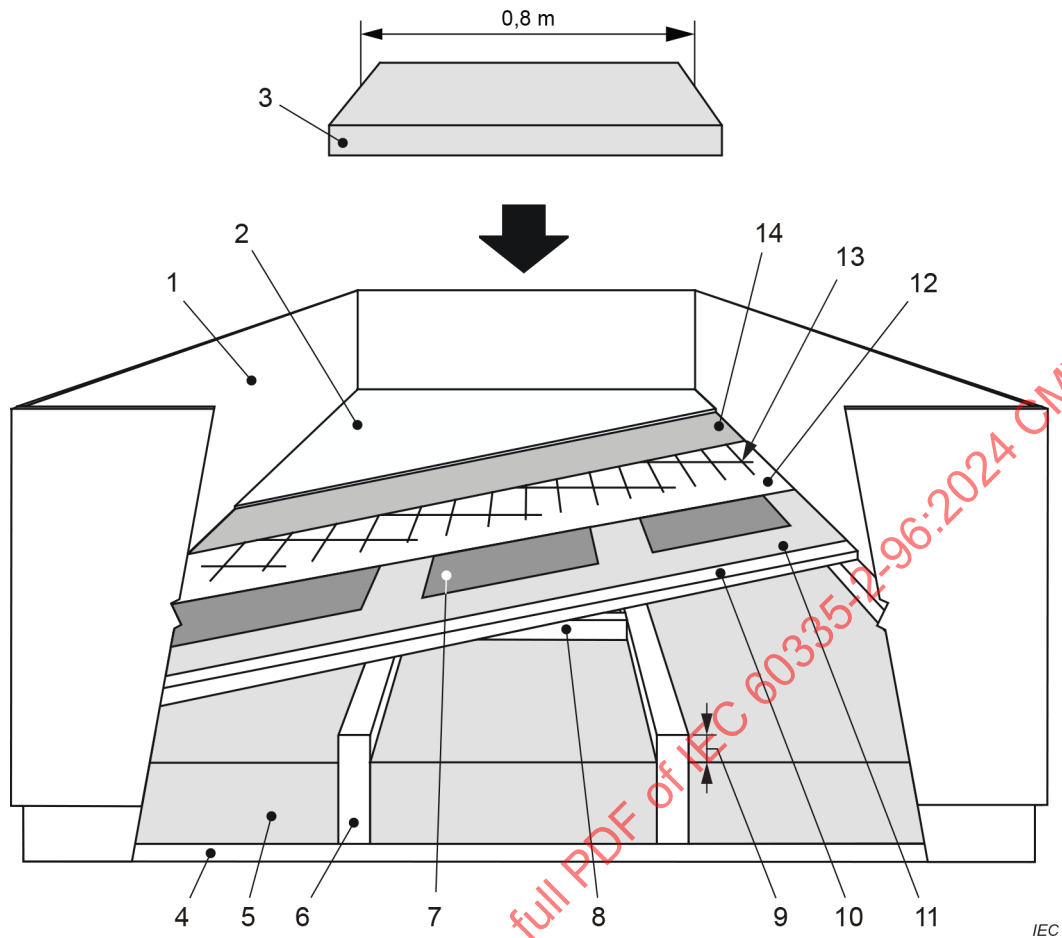


IEC

Key

- 1 wooden board
- 2 floor
- 3 piece of insulation
- 4 support for thermal insulation
- 5 thermal insulation
- 6 50 mm × 200 mm timber frame
- 7 heating unit
- 8 cross member
- 9 air gap

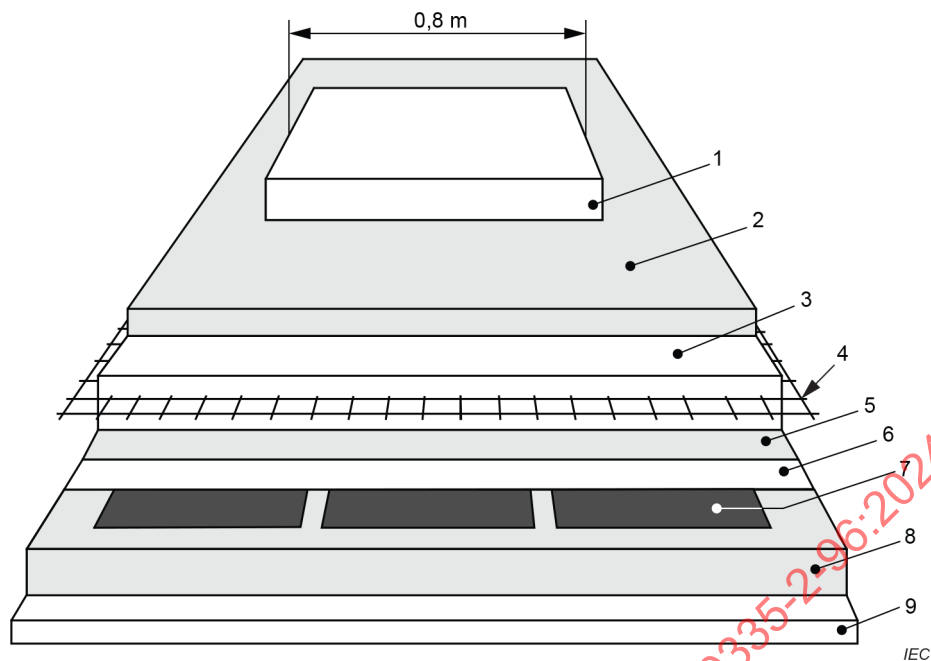
Figure 103 – Arrangement for testing heating units in timber floors



Key

- 1 wooden board
- 2 floor
- 3 piece of insulation
- 4 support for thermal insulation
- 5 thermal insulation
- 6 50 mm × 200 mm timber frame
- 7 heating unit
- 8 cross member
- 9 air gap (if specified)
- 10 plywood
- 11 additional material (if specified)
- 12 additional electrical insulation (if specified)
- 13 grid
- 14 additional layer (if specified)

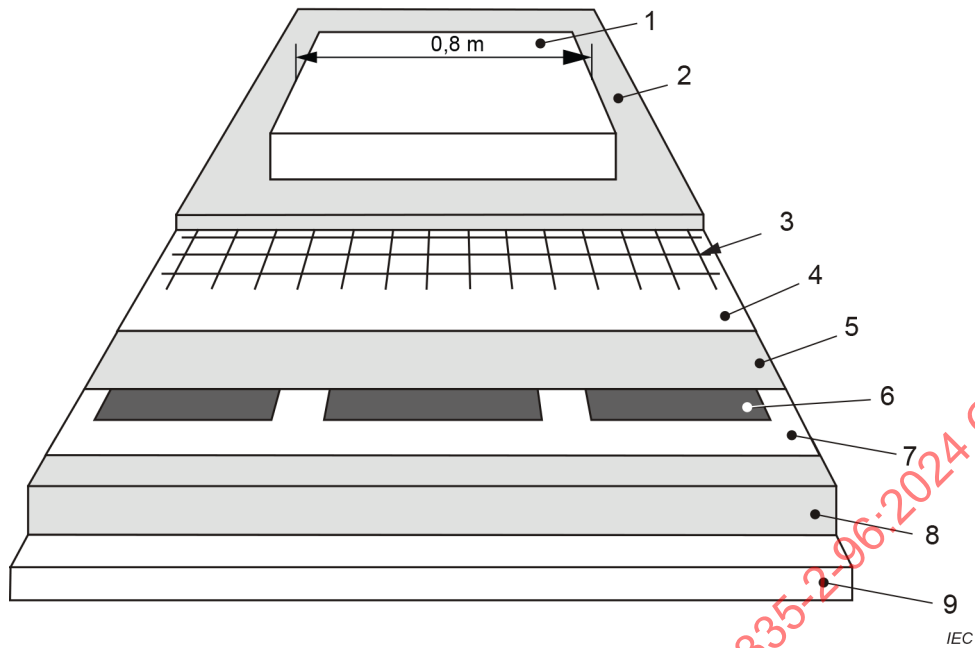
Figure 104 – Arrangement for testing heating units above timber floors



Key

- 1 piece of insulation
- 2 flooring
- 3 concrete
- 4 grid (if specified)
- 5 additional layer (if specified)
- 6 additional electrical insulation (if specified)
- 7 heating unit
- 8 thermal insulation
- 9 plywood

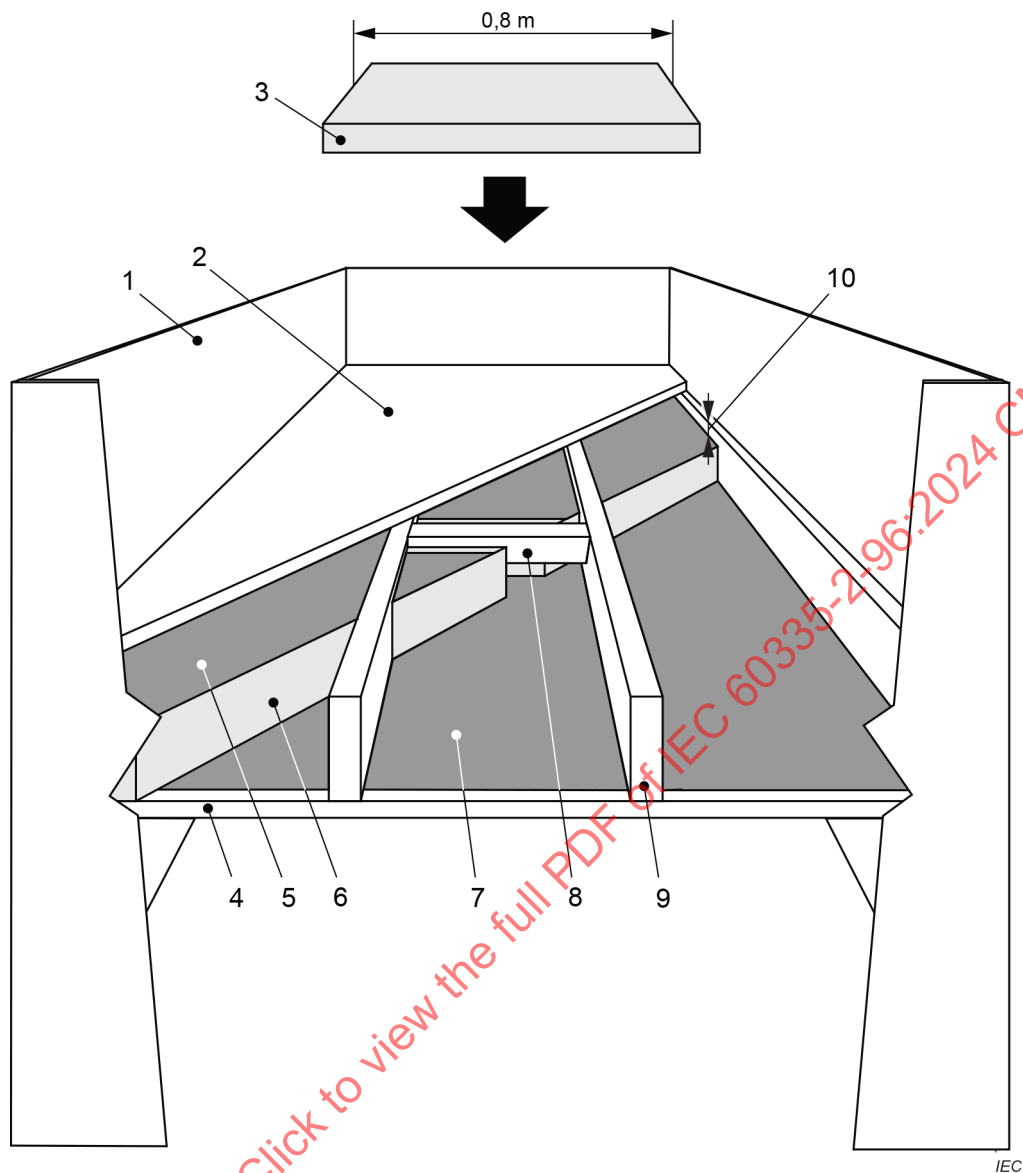
Figure 104 105 – Arrangement for testing heating units below concrete



Key

- 1 piece of insulation
- 2 floor
- 3 grid
- 4 additional layer (if specified)
- 5 additional electrical insulation (if specified)
- 6 **heating unit**
- 7 additional layer (if specified)
- 8 thermal insulation
- 9 concrete base

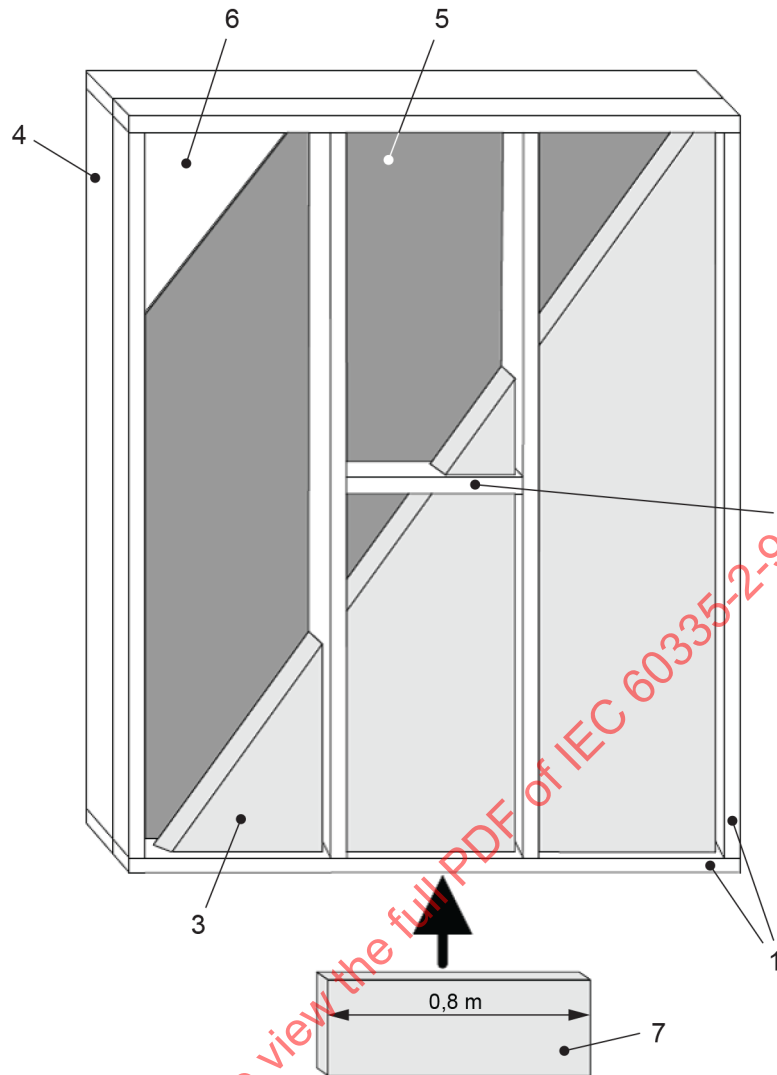
Figure 106 – Arrangement for testing heating units above concrete floors



Key

- 1 wooden board
- 2 floor
- 3 piece of insulation
- 4 covering material
- 5 floor heating unit
- 6 thermal insulation
- 7 ceiling heating unit
- 8 cross member
- 9 50 mm × 200 mm timber frame
- 10 air gap

Figure 105 107 – Arrangement for testing heating units in timber floors and ceilings in combination

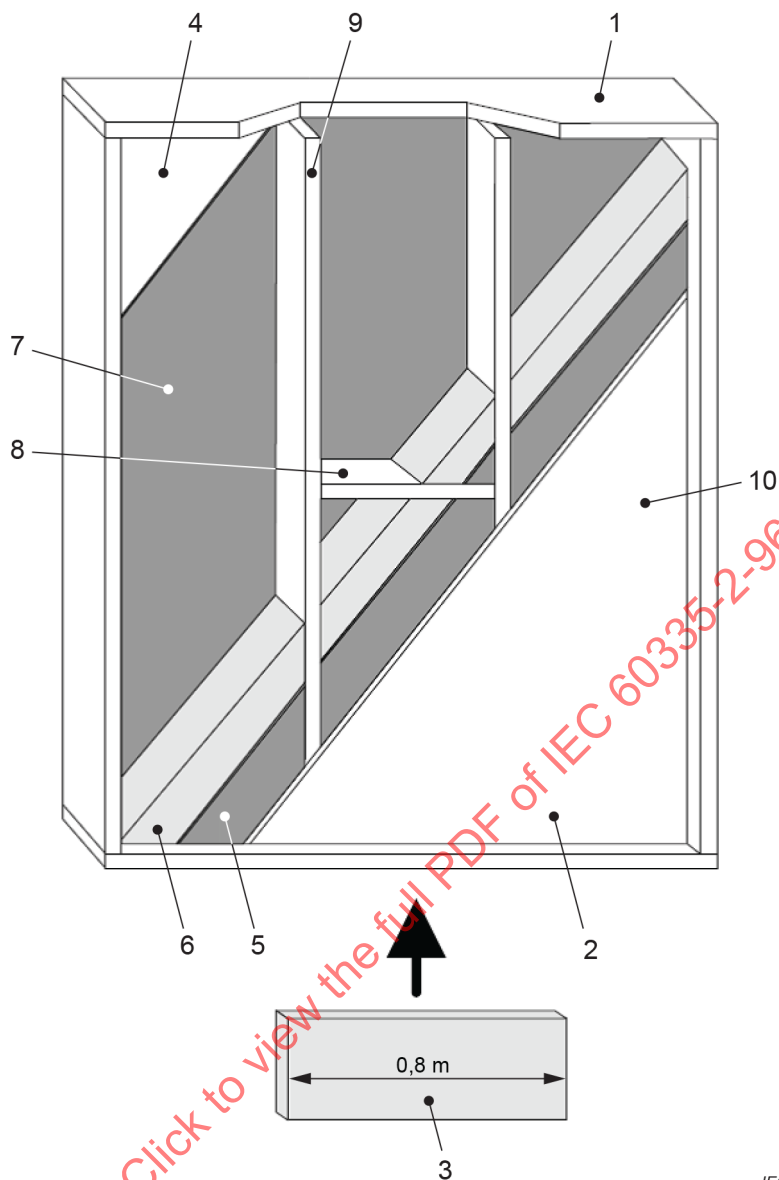


IEC

Key

- 1 50 mm × 200 mm timber frame
- 2 cross member
- 3 thermal insulation
- 4 wooden board extending approx. 0,2 m from the covering material
- 5 **heating unit**
- 6 covering material; add covering material even to the side of wall without the **flexible sheet heating element**. No air gap to be left between the covering material and the thermal insulation
- 7 piece of insulation to be inserted against the covering material

Figure 108 – Arrangement for testing heating units in timber walls

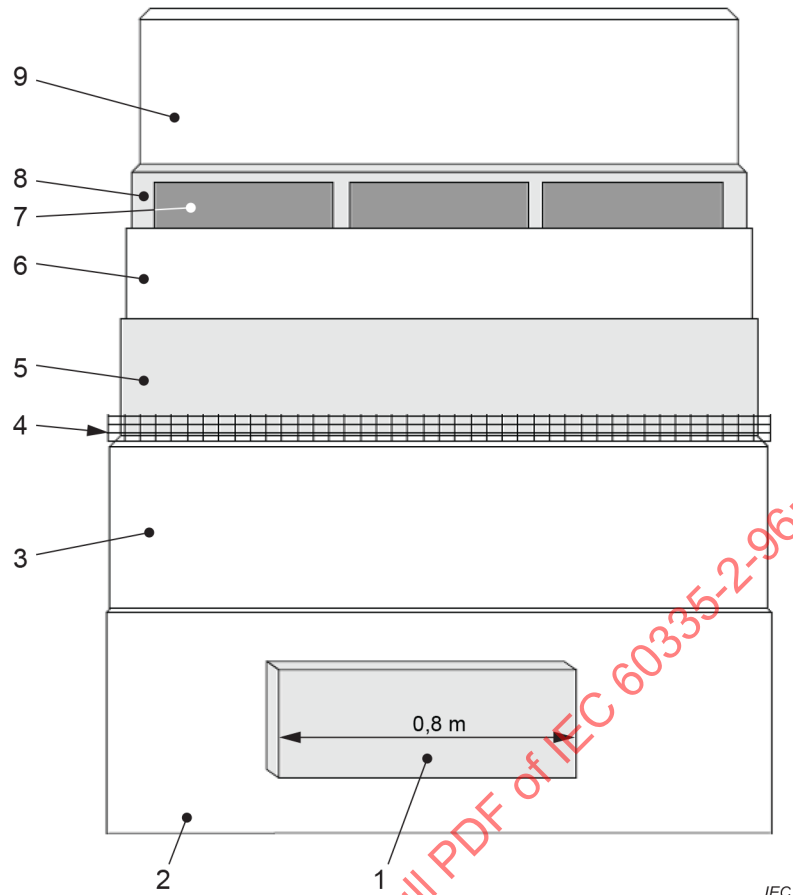


IEC

Key

- 1 wooden board extending approx. 0,2 m from the covering materials
- 2 wall covering material for **heating unit 1**
- 3 piece of insulation
- 4 wall covering material for **heating unit 2**
- 5 wall **heating unit 1**
- 6 thermal insulation
- 7 wall **heating unit 2**
- 8 cross member
- 9 50 mm × 200 mm timber frame
- 10 no air gaps for wall applications

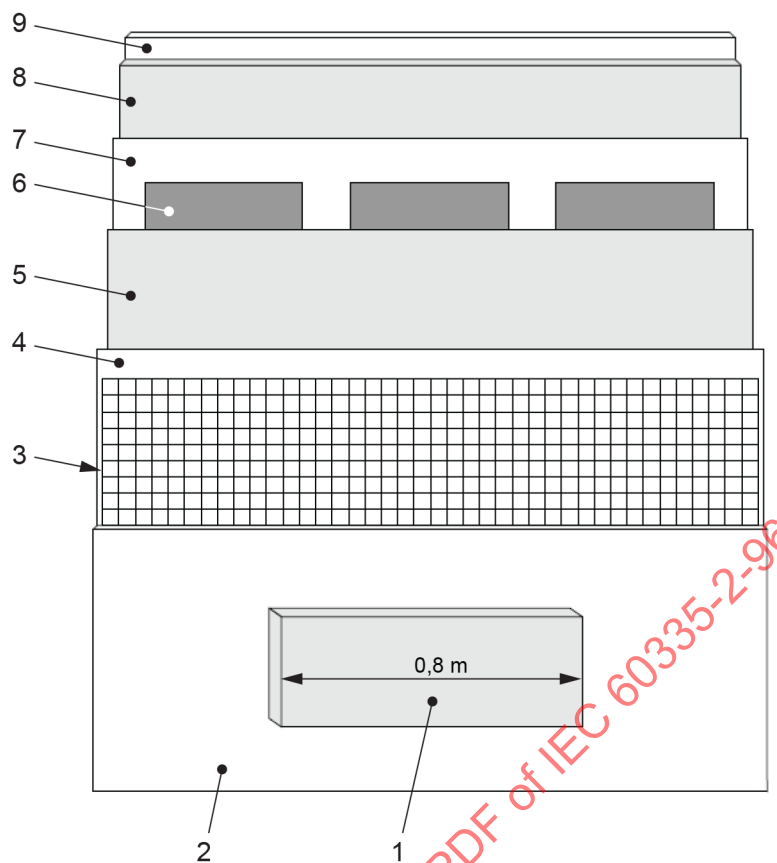
Figure 109 – Arrangement for testing heating units in both sides of timber wall applications



Key

- 1 piece of insulation
- 2 wall covering material
- 3 concrete or similar materials
- 4 grid (if specified)
- 5 additional electrical insulation (if specified)
- 6 earthed conductive screen
- 7 **heating unit**
- 8 thermal insulation
- 9 plywood

Figure 110 – Arrangement for testing heating units intended to be installed in a wall of concrete or similar materials



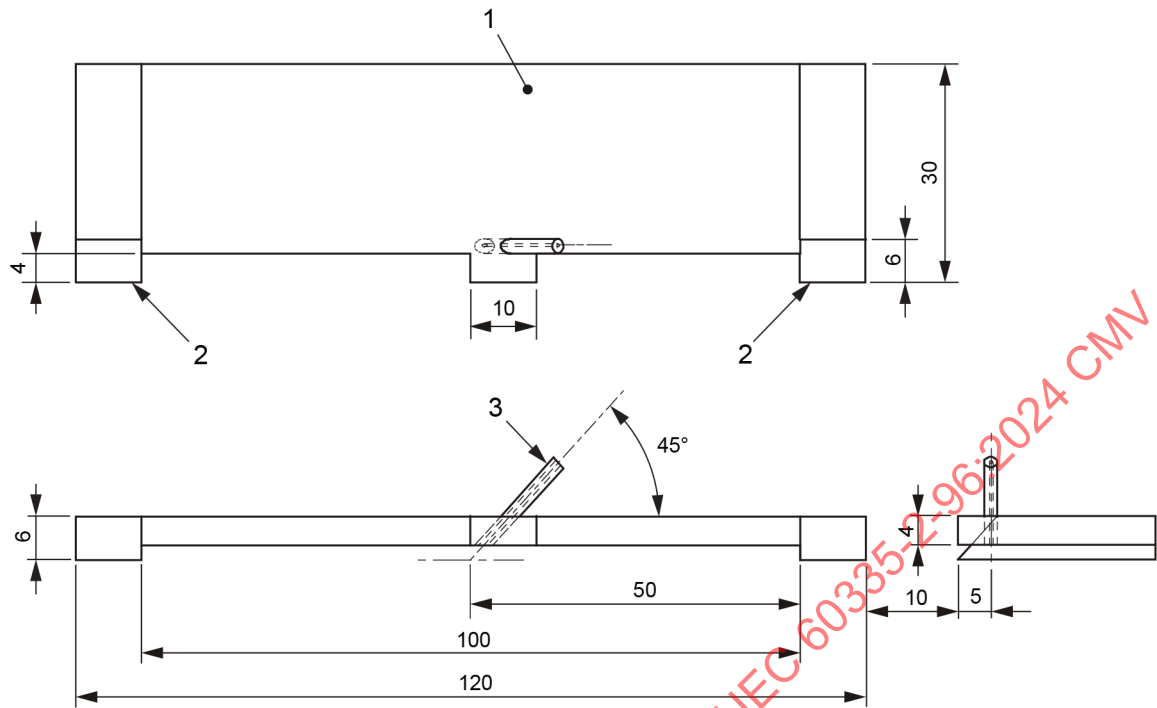
Key

- 1 piece of insulation
- 2 wall covering material
- 3 grid (if specified)
- 4 earthed conductive screen
- 5 additional electrical insulation (if specified)
- 6 **heating unit**
- 7 additional layer (if specified)
- 8 thermal insulation
- 9 concrete base

The framework is located in a vertical position.

Figure 111 – Arrangement for testing heating units against wall of concrete or similar materials

Dimensions in millimetres

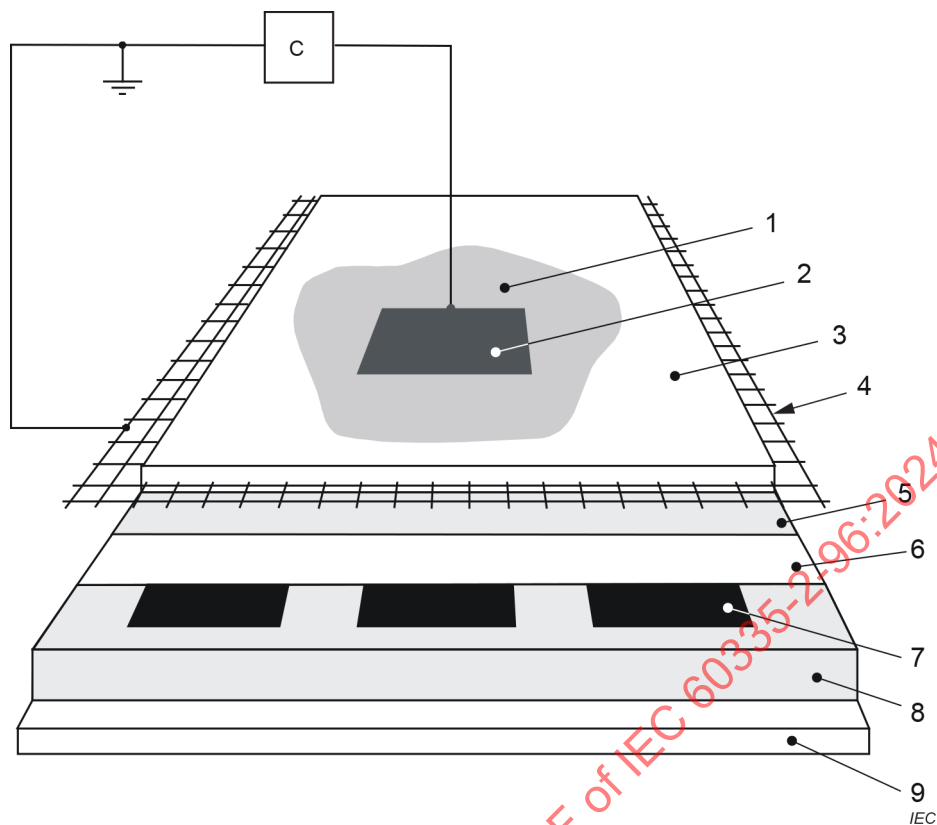


IEC

Key

- 1 jig body made from insulating material
- 2 reference edge
- 3 needle guide

Figure 106 112 – Jig for locating the contact needle



Key

C circuit of Figure 4 of IEC 60990:2016

1 saline solution

2 metal foil

3 floor covering

4 grid

5 additional layer (if specified)

6 additional electrical insulation (if specified)

7 **heating unit**

8 thermal insulation

9 plywood base

Figure 109 113 – Arrangement for measuring capacitive currents

Annexes

The annexes of Part 1 are applicable except as follows.

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Annex AA (informative)

Summary of installation instructions

Table AA.1 provides a summary of installation instructions. For correct application of this standard, the normative text in the referenced subclauses takes precedence over the summary given in this annex.

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Application							
	Wall 0,2 m to 1,2 m from floor	Wall 0,2 m to 1,2 m from floor	Ceiling	Floor			
				Dry location			Swimming pool
				Metal	Under tile	Concrete or similar materials	
Heating unit construction	Timber on one or both side(s)	Concrete or similar materials	Metal	Under tile	Concrete or similar materials	Under tile	Concrete or similar materials
Class II	RCD ^a Earthed screen ^g Protection circuit ^g	RCD ^a Earthed screen ^g Protection circuit ^g	RCD ^a or Isolating transformer ^a	RCD ^a or Isolating transformer ^a	RCD ^a or Isolating transformer ^a	RCD ^a Grid ^c or Isolating transformer ^a	RCD ^a Grid ^c

NOTE 1 Zone 0 is defined in IEC 60364-7-701.

NOTE 2 No additional requirements for under timber floor and timber ceiling applications other than those in 7.12.1.

^a Subclause 7.12.1 c)

^b Subclause 7.12.1 c), 1st dot, 3rd dash

^c Subclause 7.12.101 a)

^d Subclause 7.12.102, 1st sentence

^e Subclause 7.12.102 b), 3rd sentence

^f Subclause 7.12.103

^g Subclause 7.12.106

Bibliography

The Bibliography of Part 1 is applicable except as follows:

Addition:

IEC 60335-2-17, *Household and similar electrical appliances – Safety – Part 2-17: Particular requirements for blankets, pads, clothing and similar flexible heating appliances*

IEC 60335-2-81, *Household and similar electrical appliances – Safety – Part 2-81: Particular requirements for foot warmers and heating mats*

IEC 60335-2-106, *Household and similar electrical appliances – Safety – Part 2-106: Particular requirements for heated carpets and for heating units for room heating installed under removable floor coverings*

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List of comments

- 1 This revision is for alignment with IEC 60335-1:2020.
 - 2 This revision is for alignment with IEC 60335-1:2020.
 - 3 This revision is for alignment with IEC 60335-1:2020.
 - 4 This revision maintains the normal operation while charging as specified in IEC 60335-1:2020.
 - 5 This revision maintains the requirements for appliance outlets and socket outlets as specified in IEC 60335-1:2020.
 - 6 This revision is for alignment with IEC 60335-1:2020.
 - 7 This limit was in edition 1.0 of this Standard and was inadvertently removed from edition 2.0.
-

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INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Household and similar electrical appliances – Safety –
Part 2-96: Particular requirements for flexible sheet heating elements for room
heating**

**Appareils électrodomestiques et analogues – Sécurité –
Partie 2-96: Exigences particulières pour les films souples chauffants pour le
chauffage des locaux**

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**HOUSEHOLD AND SIMILAR ELECTRICAL APPLIANCES –
SAFETY –****Part 2-96: Particular requirements for flexible
sheet heating elements for room heating**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of 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, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). 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. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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- 6) All users should ensure that they have the latest edition of this publication.
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- 9) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at <https://patents.iec.ch>. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 60335-2-96 has been prepared by IEC technical committee 61: Safety of household and similar electrical appliances. It is an International Standard.

This third edition cancels and replaces the second edition published in 2019. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) alignment with IEC 60335-1:2020;
- b) conversion of some notes to normative text (Clause 1, 5.2, 7.12.101);
- c) correction to reinstate the touch current limit in 22.105.

The text of this International Standard is based on the following documents:

Draft	Report on voting
61/7279/FDIS	61/7304/RVD

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts of the IEC 60335 series, under the general title: *Household and similar electrical appliances – Safety*, can be found on the IEC website.

This part 2 is to be used in conjunction with the latest edition of IEC 60335-1 and its amendments unless that edition precludes it; in that case, the latest edition that does not preclude it is used. It was established on the basis of the sixth edition (2020) 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: Particular requirements for flexible sheet heating elements for room heating.

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 following additional differences exist in the countries indicated below.

- 1: Flexible sheet heating elements that are cut on site are not allowed (France).
- 7.12.1 c): The instructions in timber floors shall state that the heating unit is to be covered with additional insulation, be supplied through an isolating transformer, or be class II (Sweden).

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

NOTE 4 The attention of National Committees is drawn to the fact that equipment manufacturers and testing organizations can need a transitional period following publication of a new, amended or revised IEC publication in which to make products in accordance with the new requirements and to equip themselves for conducting new or revised tests.

It is the recommendation of the committee that the content of this publication be adopted for implementation nationally not earlier than 12 months or later than 36 months from the date of publication.

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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.

Guidance documents concerning the application of the safety requirements for appliances can be accessed via TC 61 supporting documents on the IEC website

<https://www.iec.ch/tc61/supportingdocuments>

This information is given for the convenience of users of this International Standard and does not constitute a replacement for the normative text in this standard.

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 and takes into account the way in which electromagnetic phenomena can affect the safe operation of appliances.

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 can 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.

When a part 2 standard does not include additional requirements to cover hazards dealt with in Part 1, Part 1 applies.

NOTE 1 This means that the technical committees responsible for the part 2 standards have determined that it is not necessary to specify particular requirements for the appliance in question over and above the general requirements.

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.

NOTE 2 Horizontal publications, basic safety publications and group safety publications covering a hazard are not applicable since they have been taken into consideration when developing the general and particular requirements for the IEC 60335 series of standards.

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 which 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.

NOTE 3 Standards dealing with non-safety aspects of household appliances are:

- IEC standards published by TC 59 concerning methods of measuring performance;
- CISPR 11, CISPR 14-1 and relevant IEC 61000-3 series standards concerning electromagnetic emissions;
- CISPR 14-2 concerning electromagnetic immunity;
- IEC standards published by TC 111 concerning environmental matters.

HOUSEHOLD AND SIMILAR ELECTRICAL APPLIANCES – SAFETY –

Part 2-96: Particular requirements for flexible sheet heating elements for room heating

1 Scope

This clause of Part 1 is replaced by the following.

This part of IEC 60335 deals with the safety of **flexible sheet heating elements** intended to be incorporated into floors and walls below 1,2 m and above 2,3 m and in ceilings, their **rated voltage** being not more than 250 V for single-phase installations and 480 V for other installations including direct current (DC) supplied appliances.

Flexible sheet heating elements are converted into **heating units** that are incorporated in the building in accordance with the instructions after which the required level of protection against hazards is achieved.

Attention is drawn to the fact that

- in many countries, different wiring rules apply;
- for **heating units** intended to be used in vehicles or on-board ships or aircraft, additional requirements can be necessary;
- in many countries, additional requirements are specified by the national authorities for fire protection, the national authorities for building regulations, the national health authorities, the national authorities responsible for the protection of labour and similar authorities.

This standard does not apply to

- **heating units** intended exclusively for industrial purposes;
- **heating units** intended to be used in locations where special conditions prevail, such as the presence of a corrosive or explosive atmosphere (dust, vapour or gas);
- blankets, pads, clothing and similar flexible heating appliances (IEC 60335-2-17);
- foot warmers and heating mats (IEC 60335-2-81);
- heated carpets and for heating units for room heating installed under removable floor coverings (IEC 60335-2-106);
- **flexible sheet heating elements** incorporated in other appliances.

2 Normative references

This clause of Part 1 is applicable except as follows.

Addition:

IEC 60364-7-701, *Low-voltage electrical installations – Part 7-701: Requirements for special installations or locations – Locations containing a bath or shower*

IEC 60884-1:2022, *Plugs and socket-outlets for household and similar purposes – Part 1: General requirements*

ISO 3864-1, *Graphical symbols – Safety colours and safety signs – Part 1: Design principles for safety signs and safety markings*

3 Terms and definitions

This clause of Part 1 is applicable except as follows.

3.1 Definitions relating to physical characteristics

3.1.9 *Modification:* **normal operation**

Replace the first paragraph with the following:

operation of the **heating unit** after incorporation into the building in accordance with the instructions.

Flexible sheet heating elements, the current of which can vary depending on the length of the **flexible sheet heating elements** and those that can supply other **flexible sheet heating elements** are loaded so that the current marked on the **flexible sheet heating elements** flows through the **heating unit**.

Heating units for **storage heating applications** are charged for 75 % of the **rated charging period**.

3.1.101 **rated charging period**

longest uninterrupted charging period assigned to the **heating unit** by the manufacturer

3.2 Definitions relating to means of connection

3.2.1 *Replacement:* **supply leads**

set of wires intended for connecting the appliance to fixed wiring

3.5 Definitions relating to types of appliances

3.5.4 *Addition:*

Note 101 to entry: **Heating units** are considered to be **fixed appliances**.

3.5.101 **flexible sheet heating element**

heating element consisting of sheets of electrical insulation laminated with electrical resistance material, or a base material on which electrically insulated heating wires are fixed

Note 1 to entry: This definition does not preclude other methods of combining the insulation and resistance materials.

3.5.102 **heating unit**

flexible sheet heating element equipped with means of connection to the supply and with insulation surrounding **live parts**

Note 1 to entry: The **heating unit** can be partly or completely prefabricated.

3.5.103 **modular heating unit**

prefabricated assembly consisting of a **heating unit** and other materials to form a rigid construction for mounting on a ceiling

3.5.104

storage heating application

use of **heating units** to heat thermal accumulating material

Note 1 to entry: The heat is discharged naturally, the heat output being varied by adjusting the energy input.

3.6 Definitions relating to parts of an appliance

3.6.101

electrode

conductive part incorporated in a **flexible sheet heating element** for supplying the heating material

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 Replacement:

In general, eight samples are required for the tests.

The tests of 13.3 and of Clause 15 and Clause 16 are carried out on one sample.

The tests of 18.101 and of Clause 30 are carried out on one sample.

The test of 21.102 is carried out on two samples. One of these samples is also used for the test of 22.101.

The test of 22.103 is carried out on one sample.

The remaining tests are carried out on the sixth sample. The other two samples are required for incorporating into the test arrangement to create the necessary thermal environment.

*Nine samples of **modular heating units** are necessary for the tests of 11.2.102.*

Additional samples are necessary if the tests of 18.102 are carried out.

The test of 22.105 is carried out on the same sample as that used for the test of 13.2.

*Two samples of the additional layer of material, of a size necessary to cover the **heating unit**, are required if the test of 21.104 is carried out.*

NOTE 101 Additional samples can be necessary if tests have to be repeated or for testing different sizes of **heating units**.

5.3 Addition:

The test of 22.105 is carried out after the test of 13.2.

5.6 Addition:

Thermostats sensitive to room air temperature or outdoor air temperature are short circuited. However, the **thermostat** is not short circuited if it can be set so that it does not cycle.

5.10 Addition:

However, for **flexible sheet heating elements** that are cut on site, the tests are carried out after connecting the **supply leads** and protecting the edges in accordance with the instructions.

5.101 Heating units intended to be installed in walls above a height of 2,3 m are subjected to the tests for installation in ceilings.

6 Classification

This clause of Part 1 is applicable except as follows.

6.1 Addition:

It is not necessary to classify **heating units**. However, if a **heating unit** is classified, the relevant requirements apply.

6.2 Addition:

Heating units for installation in concrete or similar materials shall be at least IPX7.

Other **heating units** shall be at least IPX1.

7 Marking and instructions

This clause of Part 1 is applicable except as follows.

7.1 Modification:

Instead of the marking of **rated power input** or **rated current** the following applies:

- **heating units** shall be marked with their **rated power input**;
- **flexible sheet heating elements** without connection between adjacent elements shall be individually marked with their **rated power input**;
- other **flexible sheet heating elements** shall be marked with their **rated power input** per metre length.

Flexible sheet heating elements shall be marked with their maximum current if

- the current can vary depending on the length of the **flexible sheet heating element**;
- other **flexible sheet heating elements** can be supplied through them.

Addition:

Flexible sheet heating elements shall be marked with:

- the indication of orientation, unless **heating units** are symmetrical;
- the intended installation (ceilings, walls between 0,2 m and 1,2 m and/or above 2,3 m, or floors);
- the heating mode (direct heating or storage heating), unless intended for both modes.

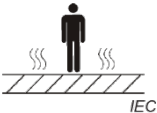
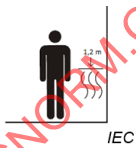
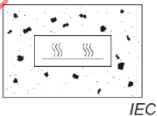
If the **heating unit** is only intended for application in floors of concrete or similar materials, it shall be marked with the symbol for installation in concrete or similar materials.

The marking shall be repeated at least once every 0,5 m of the **flexible sheet heating element** or on every section that can be cut to form a **heating unit**.

Flexible sheet heating elements that can be cut on site and have to be cut at specified places shall be marked appropriately.

Appliances with separate controls, without a control, or with **detachable controls** shall be marked with the reference number or by other means of identification of the control.

7.6 Addition:

	[symbol IEC 60417-6447 (2021-01)]	heating, direct ceiling
	[symbol IEC 60417-6446 (2021-01)]	heating, direct floor
	[symbol IEC 60417-6448 (2021-01)]	heating, floor storage
	[symbol IEC 60417-6445 (2021-01)]	heating, wall
	[symbol IEC 60417-6449 (2021-01)]	heating, installation in concrete or similar materials

These symbols are information signs and, except for the colours, the rules of ISO 3864-1 apply.

7.12.1 Addition:

Instructions shall be provided. They shall include

- a) explanation of the marking and symbols, if necessary;
- b) information for incorporating the **heating units** into the building, in particular the following:
 - precautions to be taken to avoid damage during installation, such as dropping sharp objects or stepping on the **heating unit**, or careless pouring of concrete;
 - dimensions and distances to be taken into account;
 - a statement that the **heating units** have to be separated from other heat sources such as luminaires and chimneys;
 - description of the fixing areas of the **heating unit** and the separate screen, if applicable;
 - guidance on how to avoid air gaps between the **flexible sheet heating element** and the screed of concrete floors;
 - guidance on how to avoid damage to a **flexible sheet heating element** and its terminations in timber constructions due to relative movement after installation;
 - the lowest ambient temperature at which **heating units** are recommended for installation;
 - the minimum radius for bending the **flexible sheet heating element**, if applicable;
 - a statement that **heating units** are not to be installed across expansion joints of the building or structure;
 - a statement to ensure that attachment of room fittings does not restrict heat emission from heated areas.

Except for **modular heating units**, the instructions shall include the following:

- precautions to be taken to avoid creasing the **flexible sheet heating element**;
- a statement that the **heating unit** is not to be installed on irregular surfaces;
- a description of the intended orientation and a statement that the **heating unit** is to be installed in this way (for **heating units** having non-symmetric construction);
- c) a statement that national wiring rules can apply for the installation including the following:
 - a statement that the **heating units** are to be supplied through a residual current device (RCD) having a rated residual operating current not exceeding 30 mA. The RCD shall not be of the time delayed type. Alternatively, except for installations in floors surrounding swimming pools or walls below a height of 2,3 m, they may be supplied through an isolating transformer. This statement is not required for **class III heating units** and for applications in
 - timber floors provided that the instructions for installation state that there is to be an air gap between the heating unit and the floor;
 - timber ceilings;
 - floors of concrete or similar materials in dry locations (dry locations are areas outside zone 3 as defined in IEC 60364-7-701) as long as the **basic insulation** and additional electrical insulation each withstand the electric strength test of 16.3 for **reinforced insulation**;
 - how to connect **heating units** to the supply, giving the cross-sectional area of the leads, if applicable;
 - how to interconnect the **heating units**, giving the cross-sectional area of the leads, if applicable;
 - a statement that **heating units** shall be installed to avoid increasing the ambient temperature of any existing electrical installation;
- d) the maximum current allowed to flow through one **heating unit** when other units are supplied through it or when the current can vary depending on its length;

- e) list of controls, unless they are incorporated into the **heating unit**;
- f) the maximum thermal resistance between the **heating unit** and the room;
- g) the type of covering materials that are allowed to be used in conjunction with the **heating units** with a statement that the advice of the manufacturer is to be requested before materials other than those recommended are used; the thickness of covering materials, which for floors shall be at least 5 mm;
- h) characteristics of the thermal insulation that is to be inserted between separate **heating units** installed to heat a floor and the ceiling below it;
- i) characteristics of the thermal insulation that is to be inserted between separate **heating units** installed to heat both sides of a wall;
- j) specification of any adhesive to be used;
- k) a statement that a label is to be fixed adjacent to the distribution board and that it has to contain the locations of the **heating units**;
- l) if the **heating units** are installed in a suspended ceiling, or are accessible from the roof space, a statement that a label giving this information is to be fixed to the access point of the ceiling;
- m) in applications in timber floors, a statement indicating that **heating units** having **basic insulation** only shall be covered by additional electrical insulation or supplied through an isolating transformer.

NOTE 101 A summary of particular installation requirements for different applications is given in informative Annex AA.

7.12.101 The instructions for applications in floors of concrete or similar materials, including concrete or similar materials laid on a timber floor or under tiles shall state that

- a) a grid is to be installed above the **heating unit**. The grid is to
 - be protected against corrosion but not electrically insulated;
 - be electrically and mechanically equivalent to a steel grid having a mesh not more than 50 mm × 50 mm and a wire diameter of 1 mm, unless the grid covers
 - **class II heating units**;
 - **heating units** installed with additional electrical insulation;
 - fully cover the **heating unit** including the fixing areas. It can cover several **heating units**;
 - be connected to earth;
 - be fitted with terminals suitable for the connection of two conductors each having a nominal cross-sectional area of 2,5 mm²;
 - be checked for electrical continuity during installation.

The grid is not required for

- **class III heating units**;
- **class II heating units** supplied through an isolating transformer;
- **class II heating units** that are installed in dry locations (dry locations are areas outside zone 3 as defined in IEC 60364-7-701) and are supplied through a residual current device (RCD);
- **heating units** installed in dry locations (dry locations are areas outside zone 3 as defined in IEC 60364-7-701) if the **basic insulation** and additional electrical insulation each withstand the electric strength test of 16.3 of **reinforced insulation**;
- **heating units** incorporating a metallic shield or braid having a resistance per unit length equivalent to that of 0,5 mm² copper wire;

- b) when the **heating units** have been positioned, they must be covered with an additional layer of material for mechanical protection. If the **heating units** are placed on concrete, a similar layer is to be inserted between the **heating unit** and the concrete. Adjacent layers are to overlap and be fixed to each other. The layer is to extend up each wall to the surface level of the screed. These statements are not required if
- screened insulated heating wires are covered with a sheath complying with 21.103;
 - the additional electrical insulation complies with the test of 21.102;
- c) when **heating units** having **basic insulation** only, other than those supplied at **safety extra-low voltage**, are provided with additional electrical insulation, this additional insulation is to be placed directly on the **heating unit**;
- d) **class II heating units** are to be installed at a distance of at least 30 mm from conductive parts of the building, such as water pipes.

7.12.102 The instructions for applications in metallic ceilings or metallic floors for **heating units** with **basic insulation** only, other than those supplied at **safety extra-low voltage**, shall state that

- a) the **flexible sheet heating element** is to be fully covered by the ceiling or floor;
- b) the metallic parts of the ceiling or floor are to be earthed. The instructions shall state that they have to be fitted with terminals suitable for the connection of two conductors each having a nominal cross-sectional area of 2,5 mm² and explain how the connection to the earthing terminal is to be made to ensure a low resistance. The statements regarding the need for earthing are not required if it is stated that a layer of additional electrical insulation is to be installed between the **heating unit** and the ceiling. If this insulation is not provided, the name of the manufacturer and reference of the insulation shall be given.

7.12.103 The instructions for applications on floors where the **heating units** are to be covered by tiles shall state that the **heating units** are to be covered by additional electrical insulation, unless the **heating units** are **class I**, **class II** or **class III**.

7.12.104 The instructions for **flexible sheet heating elements** that can be cut on site shall state that this work is only to be carried out by persons authorized by the manufacturer and shall give information on how to

- cut the flexible sheet heating elements;
- protect the edges of the **flexible sheet heating elements**;
- connect the **supply leads** to the interconnection leads and insulate the connections.

7.12.105 The instructions for **heating units** for **storage heating applications** shall specify the **rated charging period**.

7.12.106 Unless **heating units**

- incorporate a metallic shield or braid having a resistance per unit length equivalent to that of 0,5 mm² copper wire; or
- are of **class III**; or
- consist of a base material on which metallically screened electrically insulated heating wires are fixed and are for application in walls below a height of 1,2 m,

their instructions shall state that the **heating units** shall be of the type constructed with an electrical conductive screen. The **heating unit** shall be installed so that the screen is towards the covering material.

The instructions for **heating units** which are for application in walls below a height of 1,2 m and with a separate electrical conductive screen shall state that the screen shall be placed between the covering material and the **heating unit**.

The instructions for **heating units** which are for application in walls, shall state that the **heating unit** shall be installed:

- between 0,2 m and 1,2 m above the floor; or
- above 2,3 m above the floor.

The instructions for **heating units** which are for application in walls, shall include the substance of the following:

- the screen is to be connected to the earthing conductor of the fixed installation;
- if the heating unit is installed in an internal wall with the distance between the wall materials less than 50 mm, the heating unit shall be installed so that the screen is towards the wall covering material on both sides of the heating unit.

The instructions for **heating units** with **detachable protection circuit** shall give instructions for their installation.

7.14 Modification:

The test with petroleum spirit is not carried out.

Addition:

If symbols are used relating to the intended installation or heating mode, the superimposed rectangle shall have a height of at least 15 mm.

7.15 Modification:

Only the requirements for switches and controls are applicable.

7.101 A label that contains space for the locations of the **heating units** to be listed by the installer shall be provided for each installation giving

- the name, trademark or identification mark of the manufacturer or responsible vendor;
- the model or type reference.

It shall state the substance of the following:

- flexible sheet heating units are installed in the ceiling, wall, or floor, as applicable;
- do not restrict the thermal emission of the heated ceiling, wall or floor, as applicable;
- do not affix materials other than those recommended;
- do not insert nails, screws and do not drill in other than heating free areas;
- this label shall be fixed to or adjacent to the distribution board that supplies the heating unit.

If **heating units** are installed in walls below a height of 1,2 m, the label shall state the locations of the heating free areas or heated areas.

Compliance is checked by inspection.

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 except as follows.

10.1 Addition:

The requirement also applies to the **rated power input** per metre length of **flexible sheet heating elements**.

11 Heating

This clause of Part 1 is applicable except as follows.

11.1 Addition:

The tests are carried out in a room that is maintained at an ambient temperature of $20\text{ °C} \pm 2\text{ °C}$.

11.2 Replacement:

Heating units intended to be installed in ceilings are positioned in accordance with 11.2.101.

Modular heating units for suspended ceilings are positioned in accordance with 11.2.102.

Heating units intended to be installed in floors are positioned in accordance with 11.2.103.

Separate **heating units** intended to heat a timber floor and the ceiling below it are positioned in accordance with 11.2.104.

Heating units intended to be installed in timber walls below 1,2 m are positioned in accordance with 11.2.105.

Separate **heating units** intended to heat both sides of a timber wall are positioned in accordance with 11.2.106.

Heating units intended to be installed in walls or against walls of concrete or similar materials are positioned in accordance with 11.2.107.

*If a **heating unit** is provided with a **thermostat** having a separate sensor, the sensor is located on the centre line of one of the adjacent **heating units** but at a minimum of 0,3 m outside the area of the thermal insulation placed on the floor and at a minimum 0,3 m from the edge of the heated area.*

11.2.101 Heating units intended to be installed in a timber ceiling are placed in a test framework, as shown in Figure 101. An area of at least 4 m^2 having a shorter dimension not less than 2 m is covered by at least three **heating units**, the unit under test being placed in the middle. The **heating units** are installed in accordance with the instructions, attention being paid to where they can be located under parts of timber structures such as cross-members. The upper side of the **heating units** is fully covered by a layer of thermal insulation having a thermal resistance of approximately $5\text{ m}^2\text{K/W}$. The underside of the **heating units** is covered with the most unfavourable material listed in the instructions.

The test framework is suspended so that there is a space having a height of approximately 0,3 m above its upper surface and at least 1,5 m below the lower surface. The test framework is surrounded by wooden boards extending approximately 0,2 m below its lower surface.

If the instruction for installation allows the use of gypsum boards as a covering material, an additional test is carried out using this material.

Heating units intended to be installed in a metallic ceiling are installed in accordance with the instructions.

11.2.102 Nine **modular heating units** are installed in accordance with the instructions. They are arranged in a three-by-three matrix, the **heating unit** under test being located in the centre as shown in Figure 102. However, if a dimension of the matrix is less than 1,8 m, additional **heating units** are installed. The upper surface of the matrix is fully covered with a layer of thermal insulation so that the total thermal resistance above the **flexible sheet heating elements** is approximately 5 m²K/W. The insulation is positioned so that it is in full contact with the top surfaces of the **heating units**.

The test framework is suspended so that there is a space having a height of approximately 0,3 m above its upper surface and at least 1,5 m below its lower surface. The test framework is surrounded by wooden boards extending approximately 0,2 m below its lower surface and up to the ceiling of the room.

11.2.103 **Heating units** intended to be installed in a timber floor are placed in a test framework, as shown in Figure 103. **Heating units** intended to be installed on top of a timber floor are placed in a test framework as shown in Figure 104. An area of at least 4 m² having a shorter dimension not less than 2 m is covered by at least three **heating units**, the unit under test being placed in the middle. Thermal insulation having a thermal resistance of approximately 5 m²K/W is located below the **heating units**. The **heating units** are installed in accordance with the instructions for installation, attention being paid to where they can be located over parts of the timber structure such as cross-members. The upper side of the framework is covered with the most unfavourable floor with regard to the total thermal resistance in accordance with the instructions for installation, an air gap being maintained as shown in the figures, if specified in the instructions.

The test framework has a free space of at least 0,1 m below its lower surface and at least 1,5 m above its upper surface. The test framework is surrounded by wooden boards extending at least 1 m above its upper surface.

A piece of thermal insulation having a thermal resistance of approximately 1,25 m²K/W is placed on the floor centrally across the **heating units**, as shown in Figure 103 and Figure 104. The insulation has a length of 0,8 m and a width equal to that of the **heating unit**.

Heating units intended to be installed in a floor of concrete or similar materials are placed as shown in Figure 105. **Heating units** intended to be installed above a floor of concrete or similar materials are placed as shown in Figure 106. **Heating units** are installed in accordance with the instructions for installation, any specified additional electrical insulation being placed over them. An area of at least 4 m², having a shorter dimension not less than 2 m, is covered by at least three **heating units**, the unit under test being placed in the middle. Thermal insulation having a thermal resistance of approximately 2,5 m²K/W is located underneath the **heating units**. For **heating units** intended to be installed in concrete or similar materials, the thermal insulation is supported by a dull black painted plywood board approximately 20 mm thick.

The **heating units** are covered with the additional layer, if specified in the instructions. They are then covered with a layer of concrete approximately 40 mm thick or the thickness stated in the instructions, whichever is greater. Instead of pouring concrete, the concrete layer may consist of concrete slabs 40 mm thick and having dimensions at least 500 mm × 500 mm, the gaps between the slabs being filled with dry sand. If the **heating unit** is intended for a **storage heating application**, the thickness of the concrete is increased to 80 mm. The concrete layer is not included for **heating units** intended to be installed on top of a concrete floor. A grid is included in the test arrangement if specified. The floor is covered with the most unfavourable flooring material listed in the instructions for installation. There is a free space of at least 1,5 m above the floor.

Thermal insulation may be used instead to represent the most unfavourable flooring material.

A piece of thermal insulation having a thermal resistance of approximately 1,25 m²K/W is placed on the floor centrally across the **heating units**, as shown in Figure 105 and Figure 106. The insulation has a length of 0,8 m and a width equal to that of the **heating unit**.

Part of the thickness of concrete may be replaced by sand provided that the thermal resistance is maintained.

Care shall be taken to minimize air gaps in the floor and between the slabs of concrete.

In order to measure the highest temperature rise of the floor, it can be necessary to repeat the test with the covering material having the minimum thickness specified in the instructions.

Heating units intended to be installed in metallic floors are installed in accordance with the instructions.

11.2.104 Separate **heating units** intended to heat a timber floor and the ceiling below it are installed in a test framework shown in Figure 107 in accordance with the instructions. An area of at least 4 m² having a shorter dimension not less than 2,0 m is covered by two sets of at least three **heating units** separated by thermal insulation. The **heating units** under test are placed in the middle, one over the other. The insulation has a thermal resistance of approximately 1,45 m²K/W unless a lower value is specified in the instructions. The other details for the arrangement are as specified in 11.2.101 and 11.2.103 for timber constructions.

11.2.105 **Heating units** intended to be installed in timber walls below 1,2 m are placed in a test framework, as shown in Figure 108. An area of at least 4 m² having a shorter dimension not less than 2 m is covered by at least three **heating units**, the unit under test being placed in the middle. The **heating units** are installed in accordance with the instructions, attention being paid to where they can be located under parts of timber structures such as cross-members.

The side, towards the room to be heated, of the **heating units** is covered with the most unfavourable covering material listed in the instructions. The side without the **heating units** is fully covered by a layer of thermal insulation having a thermal resistance of approximately 5 m² K/W and which is held against the **heating unit** according to the instructions for installation.

Covering material is added even to the side of the wall without the **heating units**. No air gap is to be left between the covering material and the thermal insulation.

The test framework is situated so that there is a space having a width of approximately 0,3 m from its unheated surface and at least 1,5 m from the surface to be heated. The test framework is surrounded by wooden boards extending approximately 0,2 m from the covering material.

A piece of thermal insulation having a thermal resistance of approximately 1,25 m² K/W is placed against the wall towards the room centrally across the **heating units**, as shown in Figure 108. The insulation has a length of 0,8 m and a width equal to that of the **heating unit**.

If the instruction for installation allows the use of gypsum boards as a covering material, an additional test is carried out using this material.

Heating units intended to be installed in a metallic wall are installed in accordance with the instructions.

11.2.106 Separate **heating units** intended to heat a timber wall on both sides are installed in a test framework shown in Figure 109 in accordance with the instructions. An area of at least 4 m² having a shorter dimension not less than 2,0 m is covered by two sets of at least three **heating units** separated by a thermal insulation. The **heating units** under test are placed in the middle, one opposite the other. The insulation has a thermal resistance of approximately 1,45 m²K/W unless a lower value is specified in the instructions. The test framework is surrounded by wooden boards extending approximately 0,2 m from the covering material. The other details for the arrangement are as specified in 11.2.101 and 11.2.103 for timber constructions.

A piece of thermal insulation having a thermal resistance of approximately 0,9 m²K/W is placed against one of the walls centrally across the **heating units**, as shown in Figure 109. The insulation has a length of 0,8 m and a width equal to that of the **heating unit**.

11.2.107 **Heating units** intended to be installed in a wall of concrete or similar materials are placed as shown in Figure 110. **Heating units** intended to be installed against a wall of concrete or similar materials are placed as shown in Figure 111. **Heating units** are installed in accordance with the instructions for installation, any specified additional electrical insulation being placed against them. An area of at least 4 m², having a shorter dimension not less than 2 m, is covered by at least three **heating units**, the unit under test being placed in the middle. Thermal insulation having a thermal resistance of approximately 2,5 m²K/W is located on the back side of the **heating units**. For **heating units** intended to be installed in concrete or similar materials, the thermal insulation is supported by a dull black painted plywood board approximately 20 mm thick.

The **heating units** are covered with the additional layer, if specified in the instructions. They are then covered with a layer of concrete approximately 40 mm thick or the thickness stated in the instructions, whichever is greater. Instead of pouring concrete, the concrete layer may consist of concrete slabs 40 mm thick and having dimensions at least 500 mm × 500 mm, the gaps between the slabs being filled with fine grain concrete. If the **heating unit** is intended for a **storage heating application**, the thickness of the concrete is increased to 80 mm. The concrete layer is not included for **heating units** intended to be installed against a concrete wall. A grid is included in the test arrangement if specified. The wall is covered with the most unfavourable covering material listed in the instructions for installation. There is a free space of at least 1,5 m from the wall. The test framework is surrounded by wooden boards extending approximately 0,2 m from the covering material.

Care shall be taken to minimize air gaps in the wall and between the slabs of concrete.

11.7 Modification:

Replace the first paragraph with the following:

Heating units are operated until steady conditions are established.

Heating units for **storage heating applications** are operated as specified for **normal operation** or until the charging control operates for the first time if this occurs first.

11.8 Addition:

The temperature rise of surfaces shall not exceed the values shown in Table 101.

Table 101 – Temperature rise limits for surfaces

Part	Temperature rise K
Floor surface, 5 cm outside the edge of the piece of thermal insulation	22 ^a
Wood of the test framework	60
Surface of the flexible sheet heating element and additional electrical insulation ^b	–
^a For storage heating applications , the temperature rise may be up to 4 K higher for a period not exceeding 3 h.	
^b No temperature rise limit is specified. However, the temperature has to be determined in order that other tests of the standard can be carried out.	

12 Charging of metal-ion batteries

This clause of Part 1 is applicable.

13 Leakage current and electric strength at operating temperature

This clause of Part 1 is applicable except as follows.

13.1 Addition:

The **heating units** are installed as specified in 11.2, the most unfavourable covering material with respect to its electrical insulation characteristics being used.

The concrete shall be fully dry before the test.

13.2 Addition:

The value specified for **class 0 appliances** applies to **heating units** having **basic insulation** only.

The value specified for **class II appliances** applies to **heating units** intended to be installed on a conductive surface and those covered by concrete or similar materials.

If the **heating unit** is intended to be installed on a conductive surface or covered by concrete or similar materials, any additional electrical insulation specified in the instructions is placed in position.

Grids and screens of insulated heating wires are disconnected from earth.

The metal foil is placed on **accessible surfaces**. It is connected to the metal support of the test arrangement when testing **modular heating units**. The metal foil is not brought into contact with the terminations of grids or screens of insulated heating wires.

13.3 Modification:

The test is carried out directly on a **heating unit** and additional electrical insulation. The test voltage is applied after they have been conditioned for a period of 1 h at the temperature determined during the test of Clause 11.

14 Transient overvoltages

This clause of Part 1 is applicable.

15 Moisture resistance

This clause of Part 1 is applicable except as follows.

15.1 Addition:

*The test is carried out directly on a **heating unit**.*

15.1.1 Addition:

*IPX7 **heating units** are immersed for 72 h.*

15.1.2 Replacement:

***Heating units**, other than IPX7 **heating units**, are placed horizontally on a perforated support in accordance with IEC 60529, taking into account the marking of orientation. If the orientation is not marked, they are tested in both positions.*

15.3 Modification:

*The test is carried out directly on a **heating unit** and additional electrical insulation.*

16 Leakage current and electric strength

This clause of Part 1 is applicable except as follows.

16.1 Modification:

*The tests are carried out directly on a **heating unit** and additional electrical insulation.*

16.2 Addition:

*The value specified for **class 0 appliances** applies to **heating units** with **basic insulation** only.*

*The value specified for **class II appliances** applies to **heating units** intended to be installed on a conductive surface or covered by concrete or similar materials.*

*If the **heating unit** is intended to be installed on a conductive surface or covered by concrete or similar materials, any electrical insulation specified in the instructions is placed in position.*

16.3 Addition:

*The values specified for **class 0 appliances** apply to **heating units** with **basic insulation** only.*

*The values specified for **class II appliances** apply to **heating units** intended to be installed on a conductive surface or covered by concrete or similar materials.*

*If the **heating unit** is intended to be installed on a conductive surface or covered by concrete or similar materials, any electrical insulation specified in the instructions is placed in position.*

*For **heating units** with **basic insulation** only, other than those supplied at **safety extra-low voltage**, that are provided with additional electrical insulation for application in floors of concrete or similar materials, each insulation shall withstand the test voltage specified for **reinforced insulation**.*

*For **heating units** with **basic insulation** only, other than those supplied at **safety extra-low voltage**, that are provided with additional electrical insulation for application in metallic ceilings, this additional insulation shall withstand the test voltage specified for **supplementary insulation**.*

*For **heating units** with **basic insulation** only, other than those supplied through an isolating transformer, that are provided with additional electrical insulation for application in timber floors, this additional insulation shall withstand the test voltage specified for **supplementary insulation**.*

17 Overload protection of transformers and associated circuits

This clause of Part 1 is applicable.

18 Endurance

This clause of Part 1 is applicable except as follows.

18.101 The connections from the **flexible sheet heating element** to the **supply leads** and to interconnection leads shall be reliable.

Compliance is checked by the following test.

*The **heating unit** is placed in a heating cabinet at a temperature of $20\text{ °C} \pm 2\text{ °C}$ and is supplied with a voltage so that the current is equal to the value marked on the **flexible sheet heating element** or to the **rated current**, as applicable. The voltage drop at each connection is measured.*

*The length of the **heating unit** shall be as short as possible but not less than 0,5 m. The **heating unit** is not moved after it has been placed in the cabinet.*

*If the connections are made by using crimp connectors, the voltage drop measurement is carried out between the **supply lead** and the connector as well as between the connector and the **flexible sheet heating element**. The measuring points are as close as possible to the connections.*

*The **heating unit** is heated in cycles. Each cycle has a duration of 1 h and comprises*

- *a period of 30 min, during which*
 - *the **heating unit** is supplied with the voltage that was applied when the voltage drop was measured;*
 - *for the first 20 min, the temperature of the heating cabinet is raised to 85 °C or to the temperature of the **flexible sheet heating element** determined during the test of Clause 11, whichever is lower;*
 - *for the last 10 min, the temperature of the heating cabinet is maintained within $\pm 5\text{ K}$ of this temperature;*
- *a period of 20 min, during which the temperature is lowered to approximately 30 °C ;*
- *a stabilization period of 10 min.*

The temperature in the heating cabinet is measured at a distance of at least 50 mm from the **heating unit**. Forced cooling may be used.

The test is carried out for 400 cycles. The temperature of the heating cabinet is then reduced to $20\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ and the voltage drop at each connection is measured again.

The voltage drop shall not exceed 22,5 mV or 1,5 times the first value measured, whichever is lower.

After the test, inspection shall show no damage to the extent that compliance with this standard is impaired.

18.102 The electrical connections between the resistance material and **electrodes of flexible sheet heating elements** shall be reliable.

Compliance is checked by tests that are carried out on two **heating units**, each having a length exceeding 1 m.

One **heating unit** is subjected to the test of 18.102.2 after which it is subjected to the test of 18.102.5. The other **heating unit** is subjected to the tests of 18.102.1 to 18.102.5.

After the tests, the voltage drop of the second **heating unit**, determined at the location where bending is applied during the tests of 18.102.2, shall not exceed 1,5 times the voltage drop that was determined on the first **heating unit**. In addition, the average voltage drop determined at the other locations of the second **heating unit**, shall not exceed 1,5 times the average voltage drop of the first **heating unit**.

Inspection shall show no contact degradation such as pitting under the **electrodes** or damage adjacent to the **electrodes**.

18.102.1 The **heating unit** is wound on a cylindrical mandrel having a diameter equal to twice the minimum radius for bending the **flexible sheet heating element** specified in the instructions and then unwound. This is repeated with the other face of the **flexible sheet heating element** against the mandrel.

The test is carried out three times.

If the instructions state that the **heating unit** is only to be wound in one direction, the test is carried out six times in this direction.

18.102.2 Part of the **heating unit** is held between two boards 100 mm thick and of a size necessary to fully cover the width of the **flexible sheet heating element**. One pair of edges of the boards is rounded with a radius of 50 mm.

The assembly is placed in an ambient temperature of $-5\text{ }^{\circ}\text{C}$ or the lowest ambient temperature specified for installation, whichever is lower. When the **flexible sheet heating element** has reached this temperature, its free end is bent over the rounded edges of the boards. It is bent through an angle of 180° and back to its normal position, in both directions. This bending operation is carried out three times.

18.102.3 The **heating unit** is placed in a humidity cabinet having a relative humidity of $80\% \pm 5\%$ and a temperature of $40\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$. It is supplied at **rated voltage** and operated for 1 h after which the supply is switched off for 1 h.

The test is carried out for 1 000 cycles.

18.102.4 The **heating unit** is subjected to the test of 18.101 which is carried out for 2 000 cycles. However, the voltage drop and inspection for damage is not determined.

18.102.5 The **heating unit** is placed on a horizontal surface and supplied at **rated voltage**. A needle is inserted into the resistance material of the **flexible sheet heating element** at an angle of 45 ° and at a distance of 5 mm from the inside edge of the **electrode**.

Any conductive material between the **electrode** and the resistance material is considered to be part of the **electrode**. A jig such as that shown in Figure 112 may be used to locate the needle.

The voltage (U_m) between the needle and the supply connection to the **electrode** is measured.

Compensation for the voltage drop in the **electrode** itself is allowed.

The voltage drop (ΔU) at the contact is determined from the following formula:

$$\Delta U = U_m \frac{5U_r}{d}$$

where

U_m is the voltage measured between the needle and the supply connection to the **electrode**;

U_r is the rated voltage of the heating unit;

d is the distance, in millimetres, between the inside edges of the **electrodes**. If the conductive path is not perpendicular to the **electrodes**, the distance is measured along the centreline of the path.

The voltage drop is determined at the location where bending is applied during the test of 18.102.2. It is also determined at not less than six other locations and the average value is calculated.

The location of the test points may be selected with the aid of thermal imaging equipment.

18.103 The resistance of the **heating unit** shall not decrease significantly during use.

Compliance is checked by the following test.

The **heating unit** is placed in a heating cabinet having a temperature 5 K higher than the temperature on the surface of the **flexible sheet heating element** determined during the test of Clause 11.

After a period of 2 h, the resistance of the **heating unit** is measured. The resistance is measured again at intervals not exceeding 72 h. The **heating unit** is left in the heating cabinet for 3 000 h. During the test, the resistance of the **heating unit** shall not decrease by more than 5 % below the value measured after the initial period of 2 h.

19 Abnormal operation

This clause of Part 1 is applicable except as follows.

19.2 Addition:

For ceiling applications, a piece of thermal insulation having a thermal resistance of approximately 0,9 m²K/W is held against the ceiling covering material and located centrally across the **heating units**. It has a length of 0,8 m and a width equal to that of the **heating unit**.

*For wall applications, a piece of thermal insulation having a thermal resistance of approximately $1,45 \text{ m}^2\text{K/W}$ is held against the wall covering material and located centrally across the **heating units**. It has a length of 0,8 m and a width equal to that of the **heating unit**.*

*For wall applications, if the **heating unit** is intended to be installed on both sides of a wall, a piece of thermal insulation having a resistance of approximately $1,45 \text{ m}^2\text{K/W}$ is held against the wall on both sides and located centrally across the **heating units**. It has a length of 0,8 m and a width equal to that of the **heating unit**.*

For floor applications, the thermal resistance of the piece of thermal insulation placed on the floor is increased to approximately $1,45 \text{ m}^2\text{K/W}$ and is placed in the most unfavourable position.

*For **storage heating applications**, the **heating units** are charged for the **rated charging period**.*

19.13 Addition:

The temperature rise of the floor and the wood of the test framework shall not exceed 150 K.

20 Stability and mechanical hazards

This clause of Part 1 is not applicable.

21 Mechanical strength

This clause of Part 1 is applicable except as follows.

21.1 Addition:

*The blows are only applied to rigid parts of the **heating unit**.*

***Heating units** are subjected to the tests of 21.101.*

***Heating units** intended to be installed in floors are also subjected to the test of 21.102.*

***Heating units** incorporating insulated wires intended to be installed in floors are also subjected to the test of 21.103.*

*The additional layer of material covering **heating units** in floors of concrete or similar materials, or under tiles, is subjected to the test of 21.104.*

*These tests are not applicable to **modular heating units**.*

21.101 *Part of the **flexible sheet heating element** is held between two boards 100 mm thick and of a size necessary to fully cover the width of the **flexible sheet heating element**. One pair of edges of the boards is rounded with a radius of 50 mm.*

*The assembly is placed in an ambient temperature of -5°C or the lowest ambient temperature specified for installation, whichever is lower. When the **flexible sheet heating element** has reached this temperature, its free end is bent over the rounded edges of the boards. It is bent through an angle of 180° and back to its normal position, in both directions. This bending operation is carried out three times.*

The **heating unit** shall then withstand the electric strength test of 16.3 and shall not be damaged to such an extent that compliance with this standard is impaired.

21.102 This test is carried out on two **heating units**. The **heating unit** is placed on a horizontal steel plate having a smooth surface and the surface of the **flexible sheet heating element** is scratched by means of a hardened steel pin, the end of which has the form of a cone with an angle of 40°. Its tip is rounded with a radius of $0,25\text{ mm} \pm 0,02\text{ mm}$. The pin is loaded so that the force exerted along its axis is $10\text{ N} \pm 0,5\text{ N}$ for applications in floors of concrete and similar materials and $5\text{ N} \pm 0,5\text{ N}$ for applications in other floors. The scratches are made by drawing the pin along the surface at a speed of approximately 20 mm/s. The pin is held at an angle of 5° to 10° from the vertical in the direction of movement.

Three scratches, at least 50 mm apart, are made on both sides of one **flexible sheet heating element**. They are made parallel with the length of the **heating unit** and at least 10 mm from one of the edges. The length of the scratches is approximately equal to the width of the **heating unit**. If the **flexible sheet heating element** incorporates **electrodes**, one of the scratches is made along one of the **electrodes**.

Two similar scratches are made across the full width on both sides of the other **flexible sheet heating element**.

The **heating unit** shall then withstand the electric strength test of 16.3.

21.103 The part of the **heating unit** containing an insulated heating wire is placed on a rigid steel plate. A steel rod, 6 mm in diameter, is placed across the heating wire so that it is only in contact in one location.

A force is applied to the rod for 30 s and has a value of

- 600 N, for **heating units** for applications in floors of concrete;
- 300 N, for **heating units** for other floor applications.

The force is applied to five different locations at least 50 mm apart.

The **heating unit** shall then withstand the electric strength test of 16.3. If the insulated heating wire contains more than one conductor, the test for **basic insulation** is also carried out between the conductors.

If the **heating unit** contains screened insulated wires covered by a sheath, the test for **basic insulation** is also carried out between the conductors and the screen.

There shall be no penetration of the sheath.

21.104 A sample of the additional layer of material is placed on a horizontal steel plate having a smooth surface and is scratched by means of a hardened steel pin, the end of which has the form of a cone with an angle of 40°. Its tip is rounded with a radius of $0,25\text{ mm} \pm 0,02\text{ mm}$. The pin is loaded so that the force exerted along its axis is $10\text{ N} \pm 0,5\text{ N}$ for applications in floors of concrete and similar materials and $5\text{ N} \pm 0,5\text{ N}$ for other applications. The pin is held at an angle of 80° to 85° to the horizontal and scratches are made by drawing the pin along the surface at a speed of approximately 20 mm/s.

Three scratches are made at least 50 mm apart. Scratches shall be at least 10 mm from one of the edges. The length of the scratches is approximately equal to the width of the **heating unit**.

Similar scratches are made on the second sample, but at right angles to the direction of the scratches on the first sample.

There shall be no penetration of the material.

22 Construction

This clause of Part 1 is applicable except as follows.

22.101 The means of connection to the supply shall be securely fixed to the **flexible sheet heating element**.

*Compliance is checked by the following test which is carried out on two **heating units**.*

*The **heating unit** is laid flat on a horizontal surface and held in position so that approximately 100 mm length of **flexible sheet heating element** together with the **supply leads** hang over the edge of the surface. The free length of the **supply leads** is approximately 300 mm.*

*A force of 60 N is applied without jerks to each **supply lead** for 1 min. The test is repeated after a rest period of 1 min.*

*There shall be no damage to the lead, connection or **flexible sheet heating element** impairing compliance with this standard. The **heating unit** shall withstand the electric strength test of 16.3.*

22.102 The insulation covering the connections and the edges of the **flexible sheet heating element** shall not affect the material of the **flexible sheet heating element**.

Compliance is checked by the following test.

*The **heating unit** is placed in a cabinet at a temperature of 80 °C or 45 °C plus the temperature rise determined during the test of Clause 11, whichever is higher. The test is carried out for 336 h.*

*After the **heating unit** has cooled down to **room temperature**, it shall withstand the electric strength test of 16.3.*

22.103 The sheets of electrical insulation of laminated **flexible sheet heating elements** shall be reliably bonded together. However, if the **heating units** are for application in a floor of concrete or similar materials, only the edges of the **flexible sheet heating element** have to be bonded.

Compliance is checked by the following test.

*Two sets of three samples having dimensions of approximately 15 mm × 150 mm are cut from a new **flexible sheet heating element**. The samples for each set are taken from the edge and from the heating surface both perpendicular and parallel to an edge. For applications in floors of concrete or similar materials, the set consists of one sample that is cut from the edges.*

*One set is placed for 336 h in a heating cabinet corresponding to the temperature of the **flexible sheet heating element** determined during the test of Clause 11.*

The layers of insulation are then separated at one end of each of the samples and attached to the clamps of a tensile machine in turn.

If it is not possible to separate the layers, specially prepared samples may be used.

The clamps are separated at a rate of 250 mm/min ± 50 mm/min.

The bond strength of each sample shall be at least 1,5 N.

The average bond strength of the conditioned samples shall be not less than 80 % of the average bond strength of the unconditioned samples.

22.104 Connecting devices fitted to **supply leads** and interconnection leads shall be of **class II construction**. It shall not be possible to separate them without the aid of a **tool**.

Compliance is checked by inspection.

22.105 Heating units of class II construction intended to be installed under floors in damp locations shall not subject the user to excessive capacitive currents.

Heating units having **basic insulation** only, but covered with additional electrical insulation, are considered to be **class II construction**.

*Compliance is checked by the following test. However, the test is not carried out if the instructions for installation specify that an air gap is required between the **heating unit** and the floor.*

*The grid is connected to earth and to a metal foil having an area approximately 200 mm × 100 mm through the measurement instrument shown in Figure 113. The surface of the floor directly above a **heating unit** is covered with 0,25 l of water containing approximately 1 % NaCl and left for 2 h. The metal foil is placed on the wet surface and the **heating units** are supplied at 1,06 times **rated voltage**.*

The capacitive current shall not exceed 0,25 mA

22.106 Heating units other than **class III heating units** for wall installations below a height of 1,2 m, shall be fitted with an earthed conductive screen which is laminated with electrical insulation or shall be provided by the manufacturer of the **heating unit** with a separate earthed conductive screen which is laminated with electrical insulation.

The conductive screen shall incorporate a terminal or wire that enables the screen to be connected to the protective conductor of the electrical installation.

The conductive screen shall fully cover the current carrying parts of the **flexible sheet heating element**.

Heating units other than **class III heating units** for wall installations below a height of 1,2 m shall incorporate or be delivered with a protection circuit that disconnects both poles of the supply within one cycle of supply frequency when the **flexible sheet heating element** insulation is penetrated.

The protection circuit shall not automatically reset or automatically reconnect the supply when the penetrating object is removed.

Compliance is checked by inspection and by the test of 22.106.1. Electrically insulated tools shall be used when the voltage is applied to the sample.

22.106.1 *The appliance is supplied at **rated voltage**. An attempt is made with a steel pin with a diameter of 1 mm, to touch the **flexible sheet heating element** in three locations. A suitable supporting surface which allows the pin to penetrate through the surface shall be used in order to ensure that the current carrying part of the **flexible sheet heating element** can be touched with the pin.*

If contact with the current carrying part of the **flexible sheet heating element** is made, a protection circuit shall operate to give all pole disconnection of the **flexible sheet heating element** within one cycle of the supply frequency.

When the test pin is removed from the contact with the current carrying part of the **flexible sheet heating element**, a manual operation shall be required to re-energize the **flexible sheet heating element**.

If the protection circuit does not rely on a connection to the supply system protective earth to cause its operation,

- the voltage on the test pin prior and during detection shall not be greater than 24 V, and
- the maximum current through the test pin shall not exceed 5 mA, when measured to earth or any of the supply conductors.

If the protection system relies on contact with a conductive layer, such as metal braiding or metal foil, to cause its operation and if the conductive layer does not comply with the requirements for **accessible metal parts** of 27.5, then the conductive layer shall be insulated from **live parts** by **reinforced insulation** or **double insulation** and be covered by a sheath complying with the requirements for **basic insulation**.

23 Internal wiring

This clause of Part 1 is applicable.

24 Components

This clause of Part 1 is applicable except as follows.

24.101 Thermal cut-outs that are necessary for compliance with Clause 19 shall be **non-self-resetting** with a trip-free mechanism.

Compliance is checked by inspection.

24.102 Controls and other components necessary for the **heating unit** to comply with this standard shall be supplied with the **flexible sheet heating element** or specified in the instructions for installation so they can be obtained separately.

Controls and other components necessary for the **heating unit** to comply with 22.106 of this standard shall be supplied with the **flexible sheet heating element**.

Compliance is checked by inspection.

25 Supply connection and external flexible cords

This clause of Part 1 is applicable except as follows.

25.3 Replacement:

Heating units, other than those that can be cut on site, shall incorporate one of the following means for permanent connection to fixed wiring:

- a set of terminals, or
- a set of **supply leads**, or
- a **supply cord**.

Heating units that can be cut on site shall be supplied with a suitable means for connection to the supply mains. **Supply leads** shall be double insulated or fitted with insulating sleeves. The sleeves shall be at least 300 mm long and have a thickness corresponding to that of a sheath of a **supply cord** (code designation 60245 IEC 53).

Compliance is checked by inspection.

25.5 Modification:

Type Z attachment is allowed.

26 Terminals for external conductors

This clause of Part 1 is applicable except as follows.

26.1 Addition:

Heating units shall not incorporate screw-type terminals.

26.5 Modification:

This requirement applies to all terminals to which connections are made during installation.

26.11 Addition:

This requirement also applies to **heating units** fitted with **supply leads**.

27 Provision for earthing

This clause of Part 1 is applicable except as follows.

27.1 Addition:

Components provided for the reduction of capacitive currents, and which are earthed, are not considered to provide provision for earthing.

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.

29.1 Modification:

Modular heating units are in overvoltage category II. Other **heating units** are in overvoltage category III.

29.3 Modification:

There are no dimensional requirements for the insulation of **heating units** or additional electrical insulation.

29.3.2 Addition:

*For **class II heating units**, there shall be two layers of insulation on the **flexible sheet heating element** and each of these layers shall withstand the electric strength test of 16.3 for **reinforced insulation**. However, if the layers are inseparable, the combination shall withstand the electric strength test of 16.3 for **reinforced insulation**.*

30 Resistance to heat and fire

This clause of Part 1 is applicable except as follows.

30.1 Addition:

*The test is not applicable to **flexible sheet heating elements**.*

The tests of IEC 60884-1:2022, 25.1 and 25.4, are applicable to the flexible parts of connecting devices.

30.2 Modification:

The requirement is not applicable to **heating units** intended for applications in concrete or similar materials.

30.2.3.1 Modification:

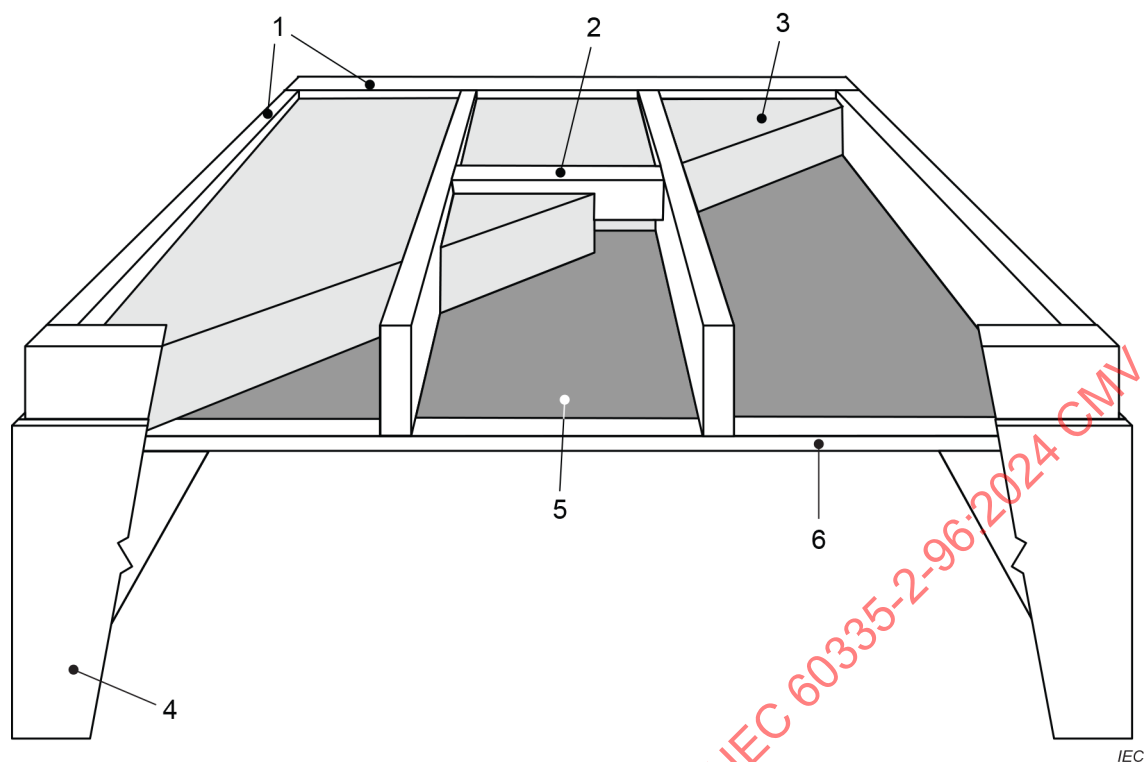
*This subclause is not applicable to **flexible sheet heating elements**.*

31 Resistance to rusting

This clause of Part 1 is applicable.

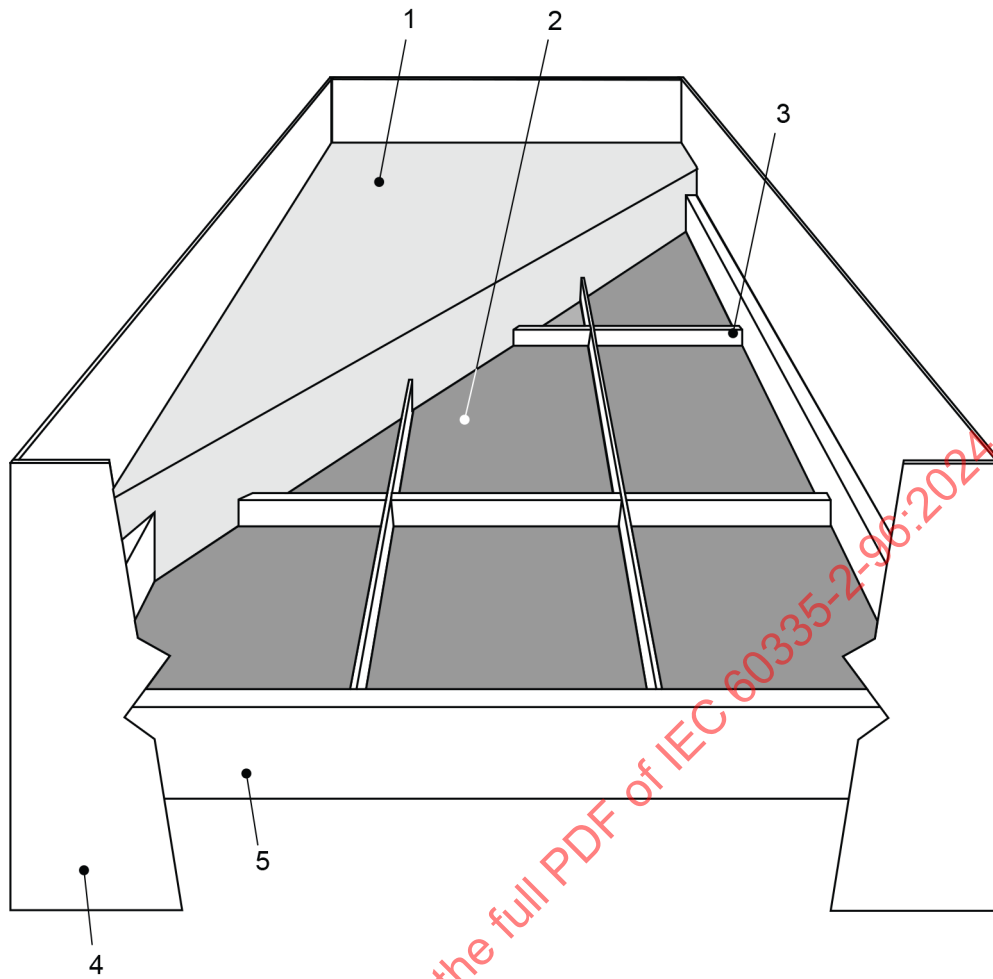
32 Radiation, toxicity and similar hazards

This clause of Part 1 is applicable.

**Key**

- 1 50 mm × 200 mm timber frame
- 2 cross member
- 3 thermal insulation
- 4 wooden board
- 5 heating unit
- 6 covering material

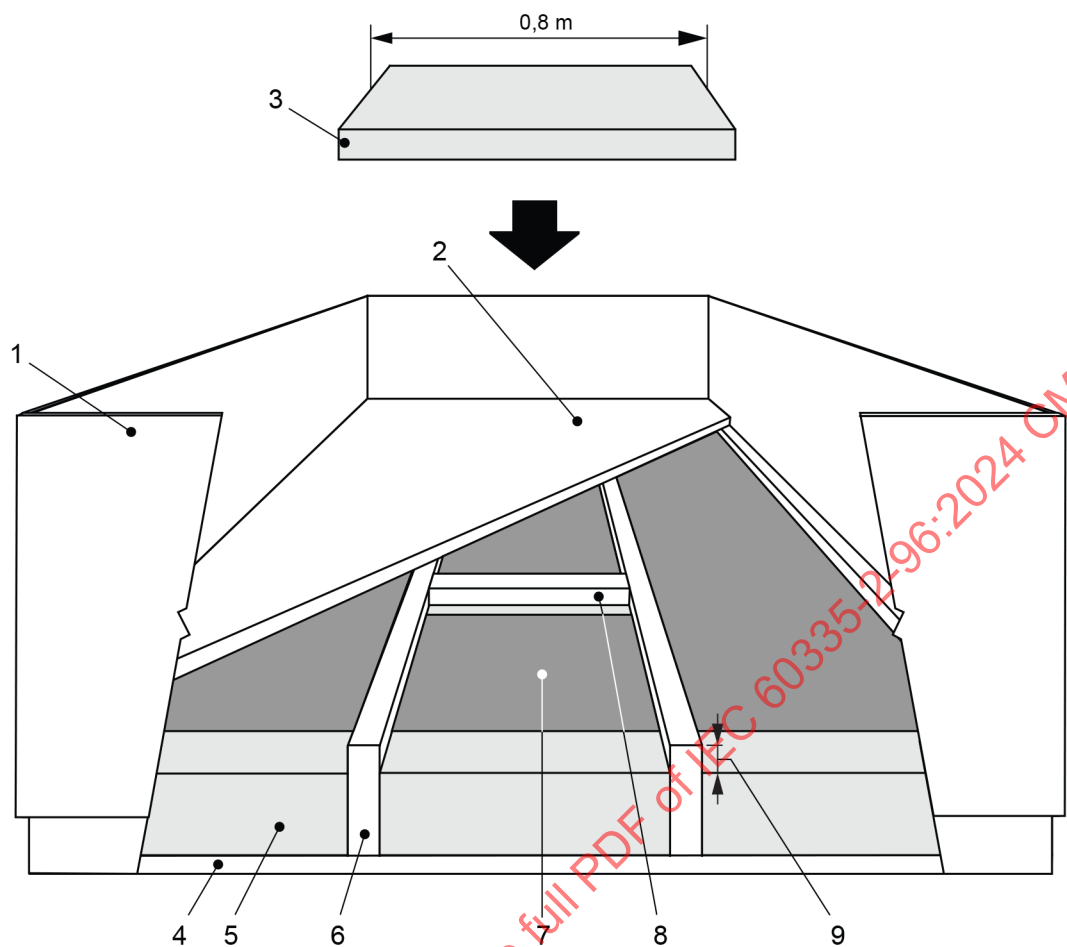
Figure 101 – Arrangement for testing heating units in timber ceilings



Key

- 1 thermal insulation
- 2 modular heating unit
- 3 support frame
- 4 wooden board
- 5 50 mm × 200 mm timber frame

Figure 102 – Arrangement for testing modular heating units

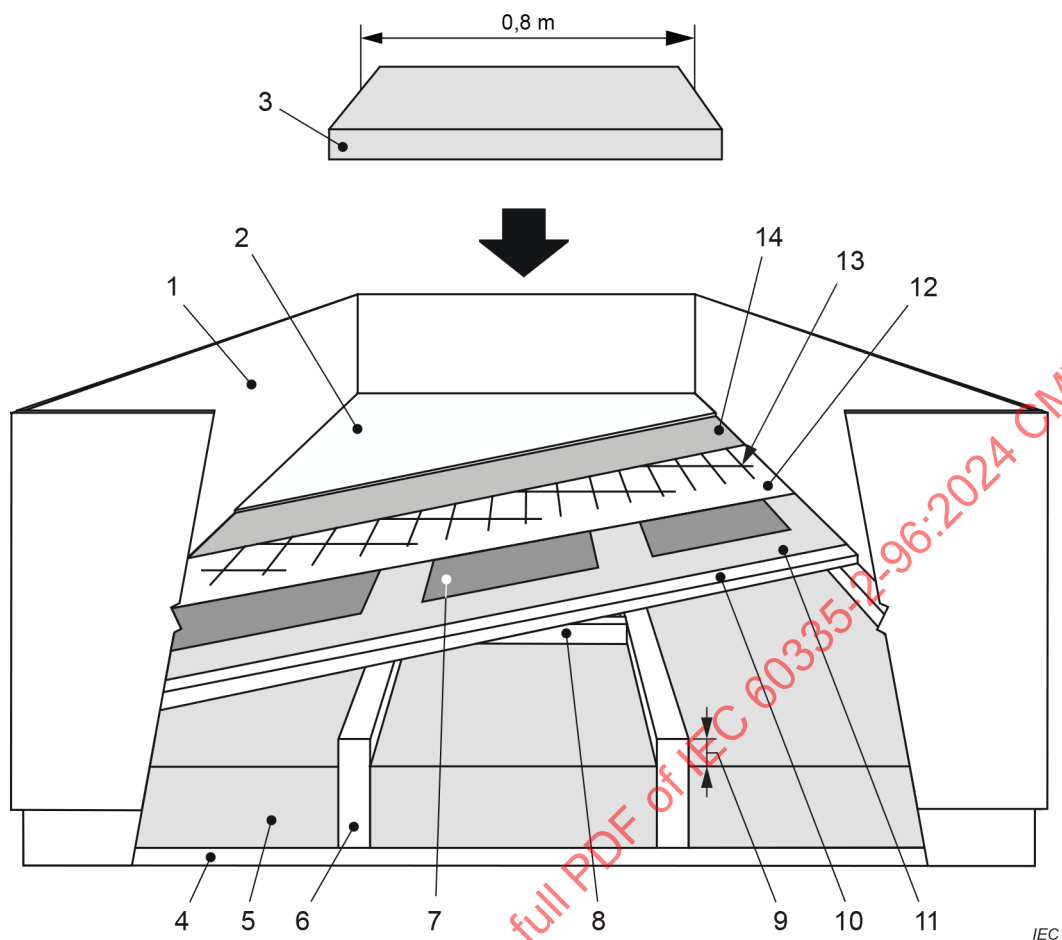


IEC

Key

- 1 wooden board
- 2 floor
- 3 piece of insulation
- 4 support for thermal insulation
- 5 thermal insulation
- 6 50 mm × 200 mm timber frame
- 7 heating unit
- 8 cross member
- 9 air gap

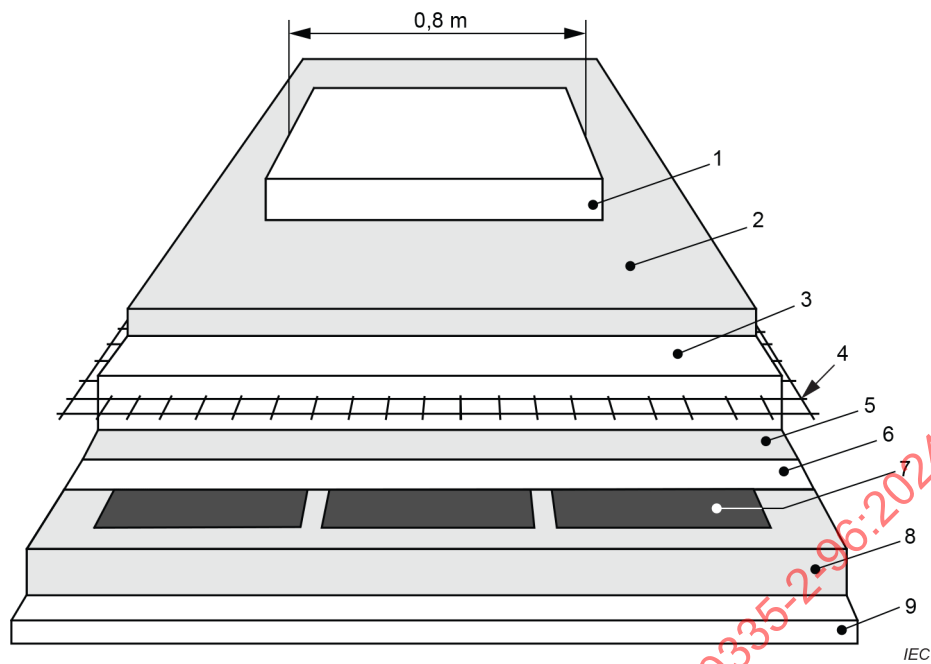
Figure 103 – Arrangement for testing heating units in timber floors



Key

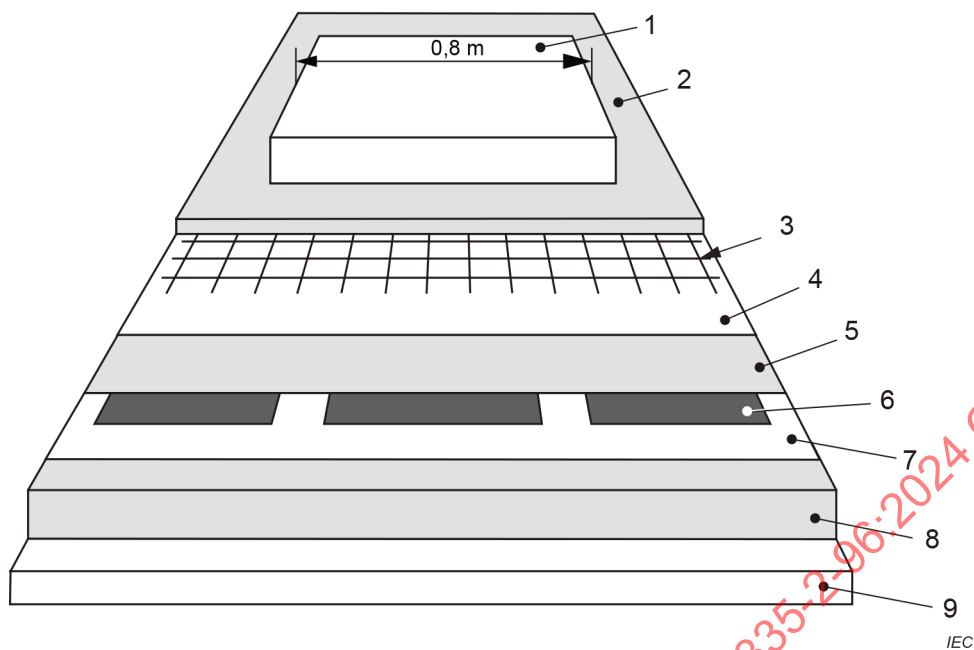
- 1 wooden board
- 2 floor
- 3 piece of insulation
- 4 support for thermal insulation
- 5 thermal insulation
- 6 50 mm × 200 mm timber frame
- 7 heating unit
- 8 cross member
- 9 air gap (if specified)
- 10 plywood
- 11 additional material (if specified)
- 12 additional electrical insulation (if specified)
- 13 grid
- 14 additional layer (if specified)

Figure 104 – Arrangement for testing heating units above timber floors

**Key**

- 1 piece of insulation
- 2 flooring
- 3 concrete
- 4 grid (if specified)
- 5 additional layer (if specified)
- 6 additional electrical insulation (if specified)
- 7 heating unit
- 8 thermal insulation
- 9 plywood

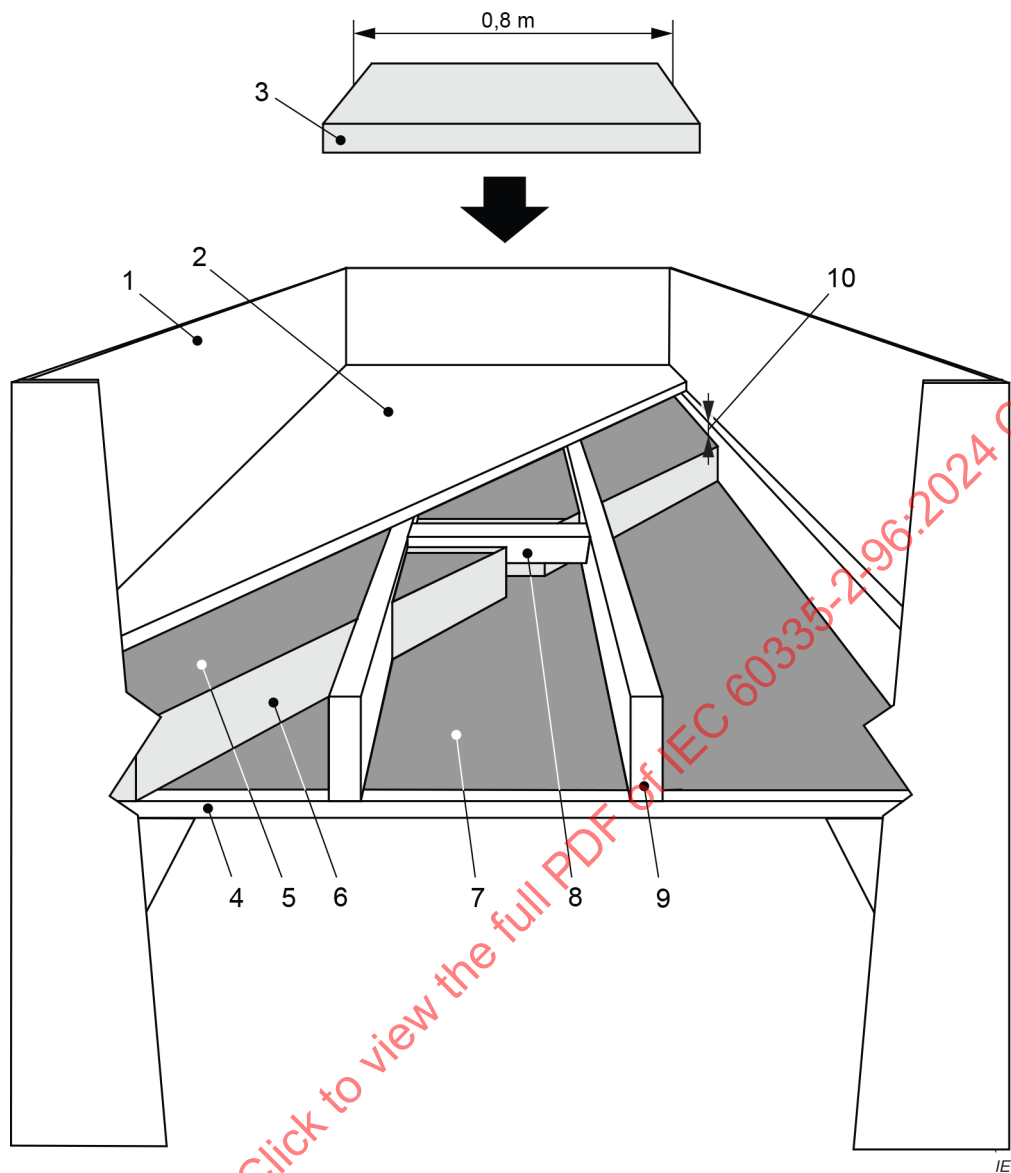
Figure 105 – Arrangement for testing heating units below concrete



Key

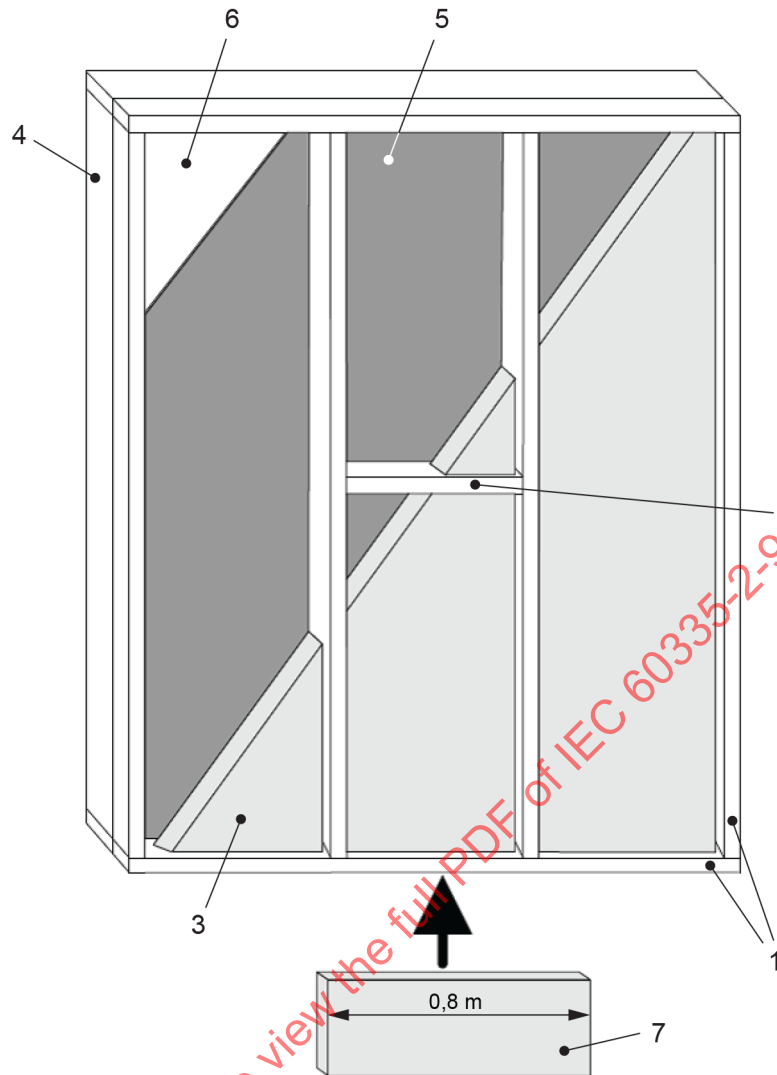
- 1 piece of insulation
- 2 floor
- 3 grid
- 4 additional layer (if specified)
- 5 additional electrical insulation (if specified)
- 6 **heating unit**
- 7 additional layer (if specified)
- 8 thermal insulation
- 9 concrete base

Figure 106 – Arrangement for testing heating units above concrete floors

**Key**

- 1 wooden board
- 2 floor
- 3 piece of insulation
- 4 covering material
- 5 floor heating unit
- 6 thermal insulation
- 7 ceiling heating unit
- 8 cross member
- 9 50 mm × 200 mm timber frame
- 10 air gap

Figure 107 – Arrangement for testing heating units in timber floors and ceilings in combination

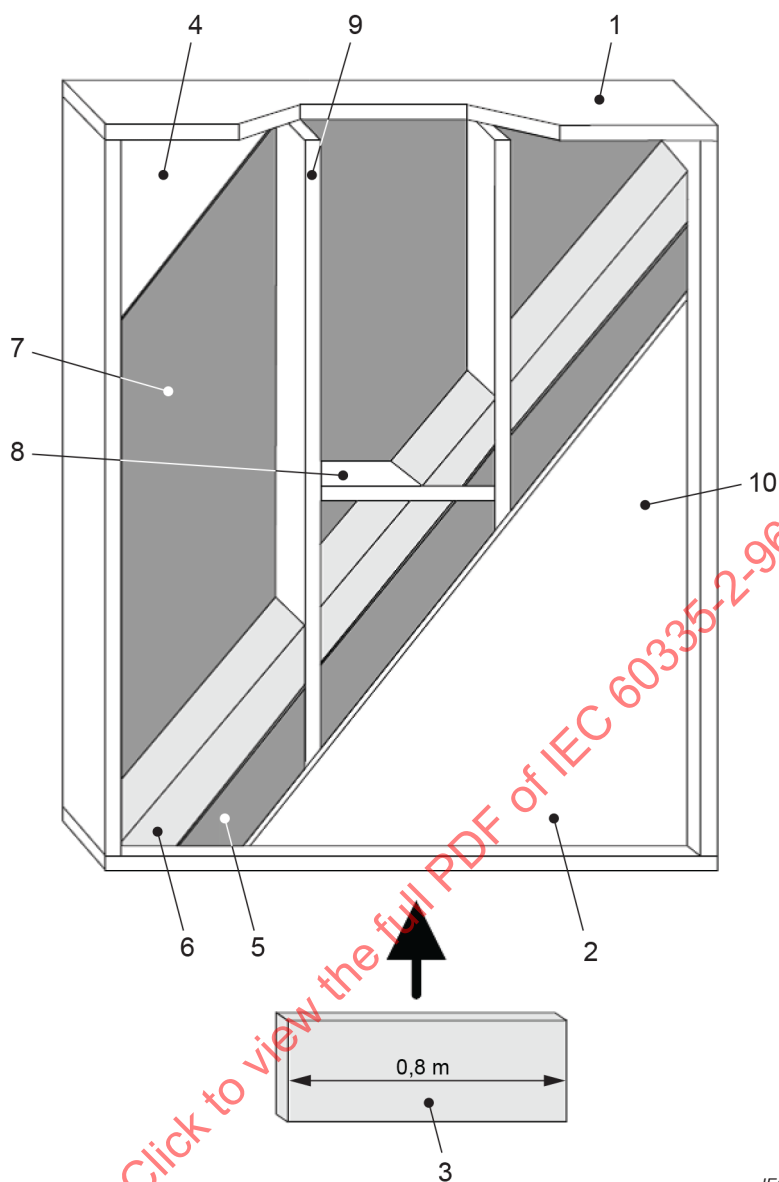


IEC

Key

- 1 50 mm × 200 mm timber frame
- 2 cross member
- 3 thermal insulation
- 4 wooden board extending approx. 0,2 m from the covering material
- 5 **heating unit**
- 6 covering material; add covering material even to the side of wall without the **flexible sheet heating element**. No air gap to be left between the covering material and the thermal insulation
- 7 piece of insulation to be inserted against the covering material

Figure 108 – Arrangement for testing heating units in timber walls

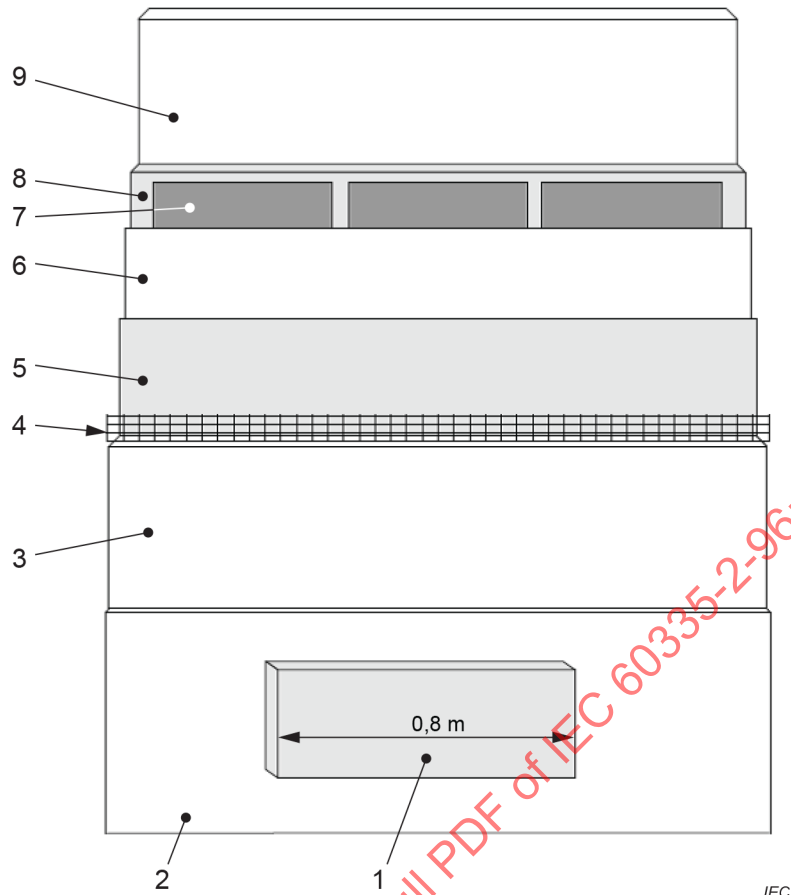


IEC

Key

- 1 wooden board extending approx. 0,2 m from the covering materials
- 2 wall covering material for **heating unit 1**
- 3 piece of insulation
- 4 wall covering material for **heating unit 2**
- 5 wall **heating unit 1**
- 6 thermal insulation
- 7 wall **heating unit 2**
- 8 cross member
- 9 50 mm × 200 mm timber frame
- 10 no air gaps for wall applications

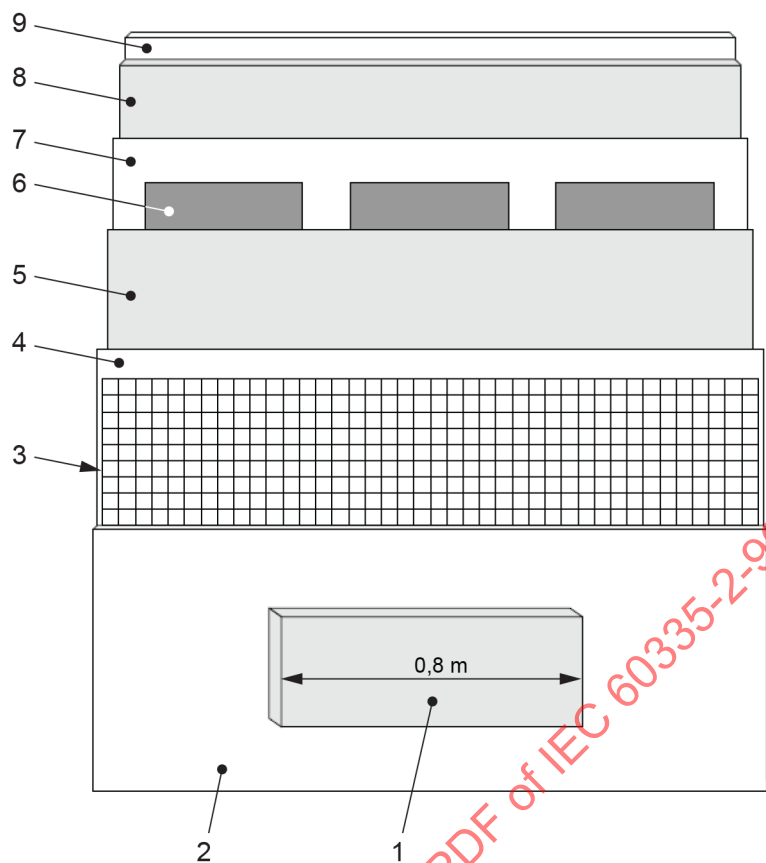
**Figure 109 – Arrangement for testing heating units
in both sides of timber wall applications**



Key

- 1 piece of insulation
- 2 wall covering material
- 3 concrete or similar materials
- 4 grid (if specified)
- 5 additional electrical insulation (if specified)
- 6 earthed conductive screen
- 7 **heating unit**
- 8 thermal insulation
- 9 plywood

Figure 110 – Arrangement for testing heating units intended to be installed in a wall of concrete or similar materials



IEC

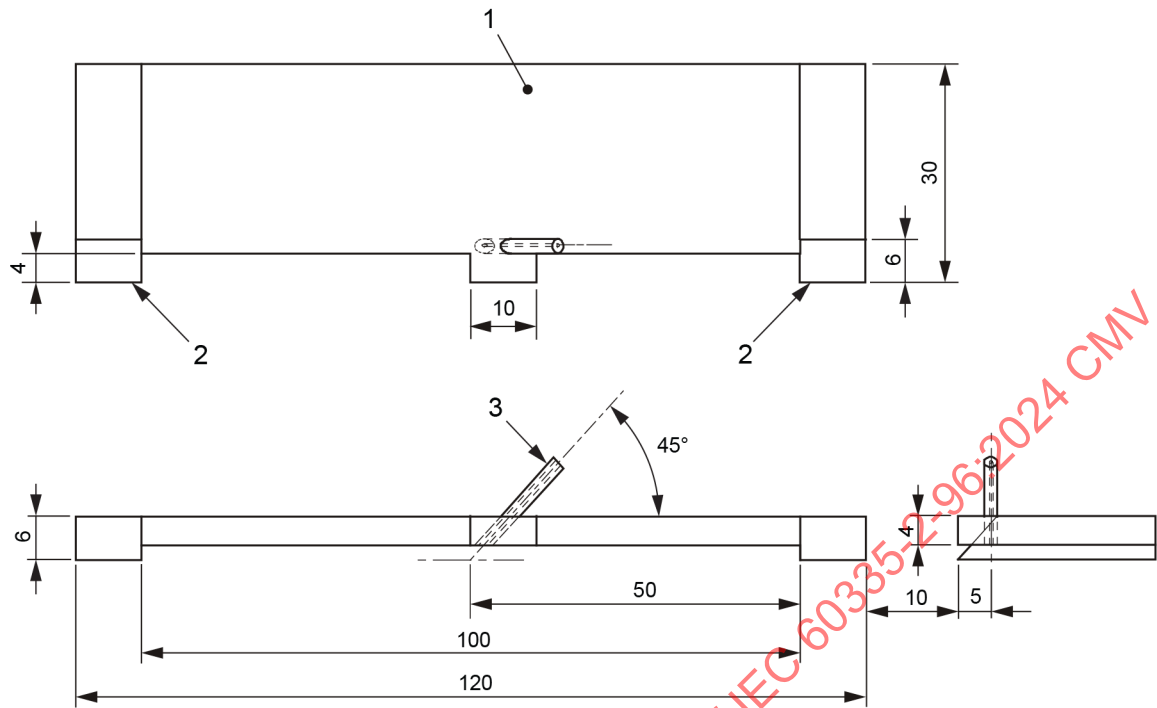
Key

- 1 piece of insulation
- 2 wall covering material
- 3 grid (if specified)
- 4 earthed conductive screen
- 5 additional electrical insulation (if specified)
- 6 **heating unit**
- 7 additional layer (if specified)
- 8 thermal insulation
- 9 concrete base

The framework is located in a vertical position.

**Figure 111 – Arrangement for testing heating units
against wall of concrete or similar materials**

Dimensions in millimetres

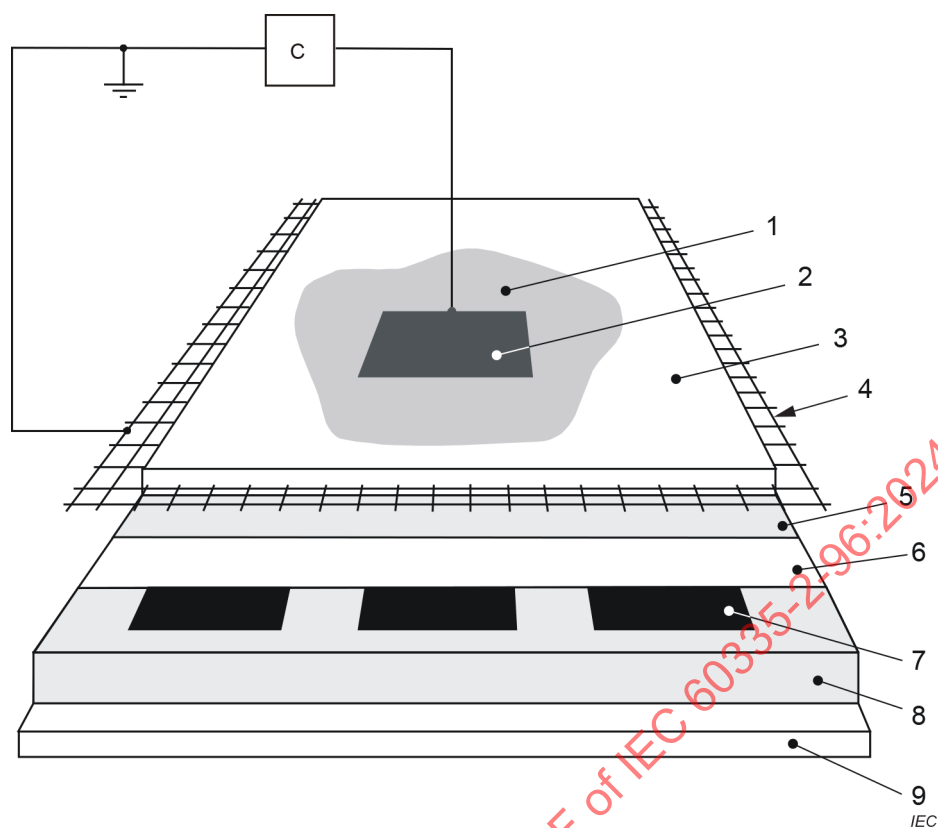


IEC

Key

- 1 jig body made from insulating material
- 2 reference edge
- 3 needle guide

Figure 112 – Jig for locating the contact needle

**Key**

C circuit of Figure 4 of IEC 60990:2016

1 saline solution

2 metal foil

3 floor covering

4 grid

5 additional layer (if specified)

6 additional electrical insulation (if specified)

7 **heating unit**

8 thermal insulation

9 plywood base

Figure 113 – Arrangement for measuring capacitive currents

Annexes

The annexes of Part 1 are applicable except as follows.

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Annex AA (informative)

Summary of installation instructions

Table AA.1 provides a summary of installation instructions. For correct application of this standard, the normative text in the referenced subclauses takes precedence over the summary given in this annex.

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Application						
	Wall 0,2 m to 1,2 m from floor	Wall 0,2 m to 1,2 m from floor	Ceiling	Floor		
				Other locations except zone 0		
				Dry location		
				Metal	Under tile	Concrete or similar materials
						Swimming pool
						Under tile
						Concrete or similar materials
Heating unit construction	Timber on one or both side(s)	Concrete or similar materials	Metal	Under tile	Concrete or similar materials	Swimming pool
Class II	RCD ^a Earthed screen ^g Protection circuit ⁹	RCD ^a Earthed screen ^g Protection circuit ⁹	RCD ^a or Isolating transformer ^a	RCD ^a or Isolating transformer ^a	RCD ^a Grid ^c or Isolating transformer ^a	RCD ^a Grid ^c RCD ^a Grid ^c

NOTE 1 Zone 0 is defined in IEC 60364-7-701.

NOTE 2 No additional requirements for under timber floor and timber ceiling applications other than those in 7.12.1.

^a Subclause 7.12.1 c)
^b Subclause 7.12.1 c), 1st dot, 3rd dash
^c Subclause 7.12.101 a)
^d Subclause 7.12.102, 1st sentence
^e Subclause 7.12.102 b), 3rd sentence
^f Subclause 7.12.103
^g Subclause 7.12.106

Bibliography

The Bibliography of Part 1 is applicable except as follows:

Addition:

IEC 60335-2-17, *Household and similar electrical appliances – Safety – Part 2-17: Particular requirements for blankets, pads, clothing and similar flexible heating appliances*

IEC 60335-2-81, *Household and similar electrical appliances – Safety – Part 2-81: Particular requirements for foot warmers and heating mats*

IEC 60335-2-106, *Household and similar electrical appliances – Safety – Part 2-106: Particular requirements for heated carpets and for heating units for room heating installed under removable floor coverings*

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COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

**APPAREILS ÉLECTRODOMESTIQUES ET ANALOGUES –
SÉCURITÉ –****Partie 2-96: Exigences particulières pour les films souples
chauffants pour le chauffage des locaux****AVANT-PROPOS**

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- 9) L'IEC attire l'attention sur le fait que la mise en application du présent document peut entraîner l'utilisation d'un ou de plusieurs brevets. L'IEC ne prend pas position quant à la preuve, à la validité et à l'applicabilité de tout droit de brevet revendiqué à cet égard. À la date de publication du présent document, l'IEC n'avait pas reçu notification qu'un ou plusieurs brevets pouvaient être nécessaires à sa mise en application. Toutefois, il y a lieu d'avertir les responsables de la mise en application du présent document que des informations plus récentes sont susceptibles de figurer dans la base de données de brevets, disponible à l'adresse <https://patents.iec.ch>. L'IEC ne saurait être tenue pour responsable de ne pas avoir identifié de tels droits de brevets et de ne pas avoir signalé leur existence.

L'IEC 60335-2-96 a été établie par le comité d'études 61 de l'IEC: Sécurité des appareils électrodomestiques et analogues. Il s'agit d'une Norme internationale.

Cette troisième édition annule et remplace la deuxième édition parue en 2019. Cette édition constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

- a) le texte a été aligné sur l'IEC 60335-1:2020;
- b) certaines notes ont été converties en texte normatif (Article 1, 5.2, 7.12.101);
- c) le 22.105 a été corrigé pour rétablir la limite du courant de contact.

Le texte de cette Norme internationale est issu des documents suivants:

Projet	Rapport de vote
61/7279/FDIS	61/7304/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à son approbation.

La langue employée pour l'élaboration de cette Norme internationale est l'anglais.

La version française n'a pas été soumise au vote.

Ce document a été rédigé selon les Directives ISO/IEC, Partie 2. Il a été développé selon les Directives ISO/IEC, Partie 1 et les Directives ISO/IEC, Supplément IEC, disponibles sous www.iec.ch/members_experts/refdocs. Les principaux types de documents développés par l'IEC sont décrits plus en détail sous www.iec.ch/publications.

Une liste de toutes les parties de la série IEC 60335, publiées sous le titre général *Appareils électrodomestiques et analogues – Sécurité*, se trouve sur le site web de l'IEC.

La présente partie 2 doit être utilisée conjointement avec la dernière édition de l'IEC 60335-1 et ses amendements sauf si cette édition l'exclut. Dans ce cas, la dernière édition qui n'exclut pas la présente partie 2 est utilisée. Elle a été établie sur la base de la sixième édition (2020) de cette norme.

NOTE 1 L'expression "la Partie 1" utilisée dans la présente norme fait référence à l'IEC 60335-1.

La présente partie 2 complète ou modifie les articles correspondants de l'IEC 60335-1, de façon à transformer cette publication en norme IEC: Exigences particulières pour les films souples chauffants pour le chauffage des locaux.

Lorsqu'un paragraphe particulier de la Partie 1 n'est pas mentionné dans cette partie 2, ce paragraphe s'applique pour autant que cela soit raisonnable. Lorsque la présente norme mentionne "addition", "modification" ou "remplacement", le texte correspondant de la Partie 1 doit être adapté en conséquence.

NOTE 2 Le système de numérotation suivant est utilisé:

- les paragraphes, tableaux et figures qui s'ajoutent à ceux de la Partie 1 sont numérotés à partir de 101;
- à l'exception de celles qui sont dans un nouveau paragraphe ou de celles qui concernent des notes de la Partie 1, les notes sont numérotées à partir de 101, y compris celles des articles ou paragraphes qui sont remplacés;
- les annexes qui sont ajoutées sont désignées AA, BB, etc.

NOTE 3 Les caractères d'imprimerie suivants sont utilisés:

- exigences: caractères romains;
- *modalités d'essais: caractères italiques;*
- notes: petits caractères romains.

Les termes en **gras** dans le texte sont définis à l'Article 3. Lorsqu'une définition concerne un adjectif, l'adjectif et le nom associé figurent également en gras.

Les différences suivantes existent également dans les pays indiqués ci-après.

- 1: Les films souples chauffants découpés sur site ne sont pas admis (France).
- 7.12.1 c): Pour les planchers bois, les instructions doivent préciser que l'unité chauffante doit être revêtue d'une isolation supplémentaire, être alimentée par l'intermédiaire d'un transformateur d'isolement ou être de la classe II (Suède).

Le comité a décidé que le contenu de ce document ne sera pas modifié avant la date de stabilité indiquée sur le site web de l'IEC sous webstore.iec.ch dans les données relatives au document recherché. À cette date, le document sera

- reconduit,
- supprimé, ou
- révisé.

NOTE 4 L'attention des Comités nationaux est attirée sur le fait que les fabricants d'appareils et les organismes d'essai peuvent avoir besoin d'une période transitoire après la publication d'une nouvelle publication IEC, ou d'une publication amendée ou révisée, pour fabriquer des produits conformes aux nouvelles exigences et pour adapter leurs équipements aux nouveaux essais ou aux essais révisés.

Le comité recommande que le contenu de cette publication soit adopté pour application nationale (obligatoire) au plus tôt 12 mois et au plus tard 36 mois après la date de publication.

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INTRODUCTION

Il a été admis par hypothèse, en établissant la présente Norme internationale, que l'exécution de ses dispositions était confiée à des personnes expérimentées et ayant une qualification appropriée.

Les documents de recommandations concernant l'application des exigences de sécurité pour les appareils peuvent être consultés dans les documents de support du CE 61, accessibles sur le site web de l'IEC à l'adresse:

<https://www.iec.ch/tc61/supportingdocuments>

Cette information est donnée à l'intention des utilisateurs de la présente Norme internationale et ne constitue nullement un remplacement du texte normatif de la présente norme.

La présente norme reconnaît le niveau de protection internationalement accepté contre les risques électriques, mécaniques, thermiques, liés au feu et au rayonnement des appareils, lorsqu'ils fonctionnent comme en usage normal en tenant compte des instructions du fabricant. Elle couvre également les situations anormales auxquelles on peut s'attendre dans la pratique et elle tient compte de la façon dont les phénomènes électromagnétiques peuvent affecter le fonctionnement sûr des appareils.

La présente norme tient compte autant que possible des exigences de l'IEC 60364, de façon à rester compatible avec les règles d'installation quand l'appareil est raccordé au réseau d'alimentation. Cependant, des règles d'installation nationales peuvent être différentes.

Si un appareil relevant du domaine d'application de la présente norme comporte également des fonctions couvertes par une autre partie 2 de l'IEC 60335, la partie 2 correspondante est appliquée à chaque fonction séparément, dans la limite du raisonnable. Si cela s'applique, l'influence d'une fonction sur les autres fonctions est prise en compte.

Lorsqu'une partie 2 ne comporte pas d'exigences complémentaires pour couvrir les dangers traités dans la Partie 1, la Partie 1 s'applique.

NOTE 1 Cela signifie que les comités d'études responsables pour les parties 2 ont déterminé qu'il n'était pas nécessaire de spécifier des exigences particulières pour l'appareil en question en plus des exigences générales.

La présente norme est une norme de famille de produits traitant de la sécurité d'appareils et a préséance sur les normes horizontales et génériques couvrant le même sujet.

NOTE 2 Les publications horizontales, les publications fondamentales de sécurité et les publications groupées de sécurité couvrant un danger ne s'appliquent pas, parce qu'elles ont été prises en considération lorsque les exigences générales et particulières ont été étudiées pour la série de normes IEC 60335.

Un appareil conforme au texte de la présente norme ne sera pas nécessairement jugé conforme aux principes de sécurité de la norme si, lorsqu'il est examiné et soumis aux essais, il apparaît qu'il présente d'autres caractéristiques qui compromettent le niveau de sécurité visé par ces exigences.

Un appareil utilisant des matériaux ou présentant des modes de construction différents de ceux décrits dans les exigences de la présente norme peut être examiné et soumis aux essais en fonction de l'objectif poursuivi par ces exigences et, s'il est jugé pratiquement équivalent, il peut être estimé conforme aux principes de sécurité de la présente norme.

NOTE 3 Les normes traitant des aspects non relatifs à la sécurité des appareils électrodomestiques sont:

- les normes IEC publiées par le comité d'études 59 concernant les méthodes de mesure d'aptitude à la fonction;
- les normes CISPR 11 et CISPR 14-1, ainsi que les normes applicables de la série IEC 61000-3 concernant les émissions électromagnétiques;
- la norme CISPR 14-2 concernant l'immunité électromagnétique;
- les normes IEC publiées par le comité d'études 111 concernant l'environnement.

APPAREILS ÉLECTRODOMESTIQUES ET ANALOGUES – SÉCURITÉ –

Partie 2-96: Exigences particulières pour les films souples chauffants pour le chauffage des locaux

1 Domaine d'application

L'article de la Partie 1 est remplacé par le texte suivant.

La présente partie de l'IEC 60335 traite de la sécurité des **films souples chauffants** destinés à être intégrés aux planchers, aux murs au-dessous d'une hauteur de 1,2 m et au-dessus d'une hauteur de 2,3 m ainsi qu'aux plafonds, leur **tension assignée** ne dépassant pas 250 V pour les installations monophasées et 480 V pour les autres installations, y compris les appareils alimentés en courant continu.

Les **films souples chauffants** sont convertis en **unités chauffantes** qui sont intégrées au bâti conformément aux instructions relatives à l'installation après laquelle le niveau de protection contre les dangers est atteint.

L'attention est attirée sur le fait que

- dans de nombreux pays, des règles d'installation différentes s'appliquent;
- pour les **unités chauffantes** destinées à être utilisées dans des véhicules ou à bord de navires ou d'avions, des exigences supplémentaires peuvent être nécessaires;
- dans de nombreux pays, des exigences supplémentaires sont spécifiées par les organismes nationaux responsables de la protection contre l'incendie, par les organismes nationaux responsables des règlements d'installation, par les organismes nationaux de la santé, par les organismes nationaux responsables de la protection des travailleurs et par des organismes similaires.

La présente norme ne s'applique pas

- aux **unités chauffantes** prévues exclusivement pour des usages industriels;
- aux **unités chauffantes** destinées à être utilisées dans des locaux qui présentent des conditions particulières, telles que la présence d'une atmosphère corrosive ou explosive (poussière, vapeur ou gaz);
- aux couvertures, coussins, vêtements et appareils chauffants souples analogues (IEC 60335-2-17);
- aux chancelières et carpettes chauffantes (IEC 60335-2-81);
- aux tapis chauffants et aux unités chauffantes pour le chauffage des locaux, installés sous des revêtements de sol amovibles (IEC 60335-2-106);
- aux **films souples chauffants** intégrés dans d'autres appareils.

2 Références normatives

L'article de la Partie 1 s'applique, avec les exceptions suivantes.

Addition:

IEC 60364-7-701, *Installations électriques à basse tension – Partie 7-701: Exigences pour les installations et emplacements spéciaux – Emplacements contenant une baignoire ou une douche*

IEC 60884-1:2022, *Prises de courant pour usages domestiques et analogues – Partie 1: Exigences générales*

ISO 3864-1, *Symboles graphiques – Couleurs de sécurité et signaux de sécurité – Partie 1: Principes de conception pour les signaux de sécurité et les marquages de sécurité*

3 Termes et Définitions

L'article de la Partie 1 s'applique, avec les exceptions suivantes.

3.1 Définitions relatives aux caractéristiques physiques

3.1.9 *Modification:*

fonctionnement normal

Remplacer le premier alinéa par ce qui suit:

fonctionnement de l'**unité chauffante** après intégration dans le bâtiment conformément aux instructions relatives à l'installation.

Les **films souples chauffants** dont le courant peut varier en fonction de leur longueur et ceux qui peuvent alimenter d'autres **films souples chauffants** sont chargés de sorte que le courant marqué sur les **films souples chauffants** circule à travers l'**unité chauffante**.

Les **unités chauffantes** pour les **applications de chauffage à accumulation** sont chargées pour 75 % de la **durée de charge assignée**

3.1.101

durée de charge assignée

période de charge ininterrompue la plus longue assignée à l'**unité chauffante** par le fabricant

3.2 Définitions relatives aux moyens de raccordement

3.2.1 *Remplacement:*

conducteurs d'alimentation

ensemble de conducteurs prévus pour connecter l'appareil à des canalisations fixes

3.5 Définitions relatives aux types d'appareils

3.5.4 *Addition:*

Note 101 à l'article: Les **unités chauffantes** sont considérées comme des **appareils installés à poste fixe**.

3.5.101

film souple chauffant

élément chauffant composé de feuilles de matériau électriquement isolant laminées avec un matériau électriquement résistant ou un matériau de base sur lequel sont fixés des conducteurs chauffants isolés électriquement

Note 1 à l'article: Cette définition n'exclut pas d'autres méthodes d'association des matériaux isolants et résistants.

3.5.102

unité chauffante

film souple chauffant équipé de moyens de connexion à l'alimentation, y compris l'isolant qui entoure les **parties actives**

Note 1 à l'article: L'**unité chauffante** peut être partiellement ou complètement préfabriquée.

3.5.103

unité chauffante modulaire

assemblage préfabriqué constitué d'une **unité chauffante** et d'autres matériaux pour former une construction rigide pour le montage sur un plafond

3.5.104

chauffage à accumulation

utilisation d'**unités chauffantes** pour chauffer un matériau qui accumule la chaleur

Note 1 à l'article: La chaleur est ultérieurement restituée par convection naturelle, la quantité de chaleur restituée étant modifiée par variation de l'énergie accumulée.

3.6 Définitions relatives aux parties d'un appareil

3.6.101

électrode

partie conductrice incorporée dans un **film souple chauffant** pour alimenter le matériau chauffant

4 Exigences générales

L'article de la Partie 1 s'applique.

5 Conditions générales d'essais

L'article de la Partie 1 s'applique, avec les exceptions suivantes.

5.2 Remplacement:

En général, huit échantillons sont exigés pour les essais.

Les essais décrits en 13.3 et à l'Article 15 et l'Article 16 sont effectués sur un échantillon.

Les essais décrits en 18.101 et à l'Article 30 sont effectués sur un échantillon.

L'essai décrit en 21.102 est effectué sur deux échantillons. L'un de ces échantillons est également utilisé pour l'essai décrit en 22.101.

L'essai décrit en 22.103 est effectué sur un échantillon.

Les essais restants sont effectués sur le sixième échantillon. Les deux autres échantillons sont exigés pour l'incorporation dans le dispositif d'essai pour créer l'environnement thermique nécessaire.

*Neuf échantillons d'**unités chauffantes modulaires** sont nécessaires pour les essais du 11.2.102.*

Des échantillons supplémentaires sont nécessaires si les essais du 18.102 sont effectués.

L'essai du 22.105 est effectué sur le même échantillon que celui utilisé pour l'essai du 13.2.

*Deux échantillons de la couche de matériau supplémentaire, d'une taille suffisante pour recouvrir l'**unité chauffante**, sont nécessaires si l'essai du 21.104 est effectué.*

NOTE 101 Des échantillons supplémentaires peuvent être nécessaires si les essais doivent être répétés ou pour les essais de différentes tailles d'**unités chauffantes**.

5.3 Addition:

L'essai du 22.105 est effectué après l'essai du 13.2.

5.6 Addition:

*Les **thermostats** sensibles à la température ambiante ou à la température extérieure sont mis en court-circuit. Toutefois, si le **thermostat** peut être réglé de façon telle qu'il ne cycle pas, il n'est pas mis en court-circuit.*

5.10 Addition:

*Cependant, pour les **films souples chauffants** qui sont découpés sur site, les essais sont effectués après raccordement des **conducteurs d'alimentation** et après avoir protégé les bords selon les instructions.*

5.101 Les **unités chauffantes** destinées à être installées dans les murs à une hauteur supérieure à 2,3 m sont soumises aux essais pour l'installation dans les plafonds.

6 Classification

L'article de la Partie 1 s'applique, avec les exceptions suivantes.

6.1 Addition:

Il n'est pas nécessaire de classer les **unités chauffantes**. Cependant, si une **unité chauffante** est classée, les exigences correspondantes s'appliquent.

6.2 Addition:

Les **unités chauffantes** pour l'installation dans le béton ou dans des matériaux similaires doivent être au moins de degré IPX7.

Les autres **unités chauffantes** doivent être au moins de degré IPX1.

7 Marquage et instructions

L'article de la Partie 1 s'applique, avec les exceptions suivantes.

7.1 Modification:

Au lieu du marquage de la **puissance assignée** ou du **courant assigné**, ce qui suit s'applique:

- les **unités chauffantes** doivent porter le marquage de leur **puissance assignée**;
- les **films souples chauffants** qui ne comportent pas de connexion entre des éléments adjacents doivent porter individuellement l'indication de leur **puissance assignée**;

- les autres **films souples chauffants** doivent porter le marquage de leur **puissance assignée** par mètre.

Les **films souples chauffants** doivent porter le marquage de leur courant maximal si:

- le courant peut varier suivant la longueur du **film souple chauffant**;
- d'autres **films souples chauffants** peuvent être alimentés par leur intermédiaire.

Addition:

Les **films souples chauffants** doivent porter:

- l'indication de l'orientation, à moins que les **unités chauffantes** soient symétriques;
- la mention de l'installation prévue (plafonds, murs compris entre 0,2 m et 1,2 m et/ou supérieurs à 2,3 m, ou planchers);
- le mode de chauffage (chauffage direct ou à accumulation), sauf s'ils sont prévus pour les deux modes.

Si l'**unité chauffante** est uniquement destinée à l'application dans des planchers en béton ou en matériaux similaires, elle doit comporter le symbole pour l'installation dans le béton ou matériaux similaires.

Le marquage doit être répété au moins une fois tous les 0,5 m sur le **film souple chauffant** ou sur chaque section qui peut être coupée pour former une unité chauffante.

Les **films souples chauffants** qui peuvent être coupés sur site et qui doivent être coupés à des emplacements spécifiés doivent porter le marquage approprié.

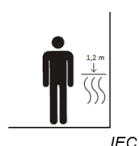
Les appareils avec des dispositifs de commande séparés, sans dispositif de commande ou avec des **dispositifs de commande amovibles** doivent porter le marquage du numéro de référence ou d'autres moyens d'identification du dispositif de commande.

7.6 Addition:[symbole IEC 60417-6447
(2021-01)]

chauffage direct par le plafond

[symbole IEC 60417-6446
(2021-01)]

chauffage direct par le plancher

[symbole IEC 60417-6448
(2021-01)]chauffage à accumulation par
le plancher[symbole IEC 60417-6445
(2021-01)]

chauffage mural

[symbole IEC 60417-6449
(2021-01)]chauffage installé dans le béton
ou dans des matériaux
similaires

Ces symboles sont des signaux d'information et, excepté pour les couleurs, les règles de l'ISO 3864-1 s'appliquent.

7.12.1 Addition:

Des instructions d'installation doivent être fournies. Elles doivent inclure:

- a) une explication des marquages et des symboles, si nécessaire;
- b) des informations concernant l'incorporation des **unités chauffantes** dans le bâtiment, en particulier les points suivants:
 - les précautions à prendre pour empêcher les détériorations pendant l'installation, telles qu'éviter de laisser tomber des objets pointus, de marcher sur l'**unité chauffante** ou de couler le béton sans précautions;
 - les dimensions et distances à prendre en compte;
 - l'indication que les **unités chauffantes** doivent être éloignées des autres sources de chaleur telles que les luminaires et les cheminées;
 - la description des zones de fixation de l'**unité chauffante** et de l'écran séparé, le cas échéant;
 - les recommandations pour éviter la formation d'espaces libres entre le **film souple chauffant** et la poutre lisseuse des planchers en béton;
 - des recommandations pour éviter la détérioration d'un **film souple chauffant** et de ses bornes dans les constructions en bois du fait de déplacements relatifs après l'installation;
 - la température ambiante la plus faible à laquelle il est recommandé d'installer les **unités chauffantes**;
 - le rayon minimal de pliage du **film souple chauffant**, le cas échéant;

- une indication qui précise que les **unités chauffantes** ne doivent pas être installées sur les joints de dilatation du bâtiment ou de la structure;
- une indication destinée à s'assurer que la fixation des aménagements des locaux ne restreint pas l'émission de chaleur à partir des surfaces chauffées.

Sauf pour les **unités chauffantes modulaires**, les instructions doivent inclure:

- des précautions à prendre pour éviter de froisser le **film souple chauffant**;
 - une indication qui précise que l'**unité chauffante** ne doit pas être installée sur des surfaces irrégulières;
 - une description de l'orientation prévue et une indication qui précise que l'**unité chauffante** doit être installée de cette manière (pour les **unités chauffantes** de construction non symétrique);
- c) une indication qui précise que des règles d'installation nationales peuvent s'appliquer pour l'installation, y compris les points suivants:
- une indication qui précise que les **unités chauffantes** doivent être alimentées par un dispositif à courant différentiel résiduel (DDR) dont le courant différentiel de fonctionnement assigné est inférieur ou égal à 30 mA. Le DDR ne doit pas être du type retardé. En variante, sauf pour les installations dans les planchers qui entourent les piscines ou dans les murs au-dessous d'une hauteur de 2,3 m, elles peuvent être alimentées par l'intermédiaire d'un transformateur d'isolement. Cette indication n'est pas exigée pour les **unités chauffantes de la classe III** ni pour les applications dans les emplacements suivants:
 - les planchers en bois, à condition que les instructions d'installation indiquent qu'il doit y avoir un espace entre l'unité chauffante et le plancher;
 - les plafonds en bois;
 - les planchers en béton ou en matériaux similaires dans des emplacements secs tant que l'**isolation principale** et l'isolation électrique supplémentaire satisfont chacune à l'essai de rigidité diélectrique décrit en 16.3 pour l'**isolation renforcée** (des emplacements secs sont des zones situées à l'extérieur de la zone 3 définie dans l'IEC 60364-7-701);
 - la façon de raccorder les **unités chauffantes** à l'alimentation, en fournissant le cas échéant la section nominale des conducteurs;
 - la façon éventuelle de raccorder entre elles les **unités chauffantes**, en fournissant le cas échéant la section nominale des conducteurs;
 - une indication qui précise que les **unités chauffantes** doivent être installées de manière à éviter d'augmenter la température ambiante de toute installation électrique existante;
- d) le courant maximal admis dans une **unité chauffante** lorsque d'autres unités sont alimentées par son intermédiaire ou lorsque le courant peut varier suivant sa longueur;
- e) la liste des dispositifs de commande, à moins qu'ils ne soient incorporés à l'**unité chauffante**;
- f) la résistance thermique maximale entre l'**unité chauffante** et le local;
- g) le type des matériaux de revêtement qui peuvent être utilisés conjointement avec les **unités chauffantes**, avec l'indication que l'avis du fabricant doit être demandé si des matériaux autres que ceux qui sont recommandés sont utilisés; l'épaisseur des matériaux de revêtement, qui, s'agissant des planchers, doit être au moins de 5 mm;
- h) les caractéristiques de l'isolant thermique qui doit être inséré entre des **unités chauffantes** séparées installées pour chauffer un plancher et le plafond qui est au-dessous;
- i) les caractéristiques de l'isolant thermique qui doit être inséré entre des **unités chauffantes** séparées installées pour chauffer les deux côtés d'un mur;
- j) les spécifications des adhésifs à utiliser;
- k) l'indication qu'une étiquette doit être fixée en étant adjacente au tableau de distribution et qu'elle doit contenir les emplacements des **unités chauffantes**;

- l) si les **unités chauffantes** sont installées dans un plafond suspendu, ou sont accessibles d'un espace de toit, une indication qu'une étiquette portant cette information doit être fixée au point d'accès du plafond;
- m) pour les applications dans les planchers en bois, l'indication que les **unités chauffantes** qui possèdent uniquement une **isolation principale** doivent être recouvertes d'un isolant électrique supplémentaire ou alimentées à travers un transformateur d'isolement.

NOTE 101 Un récapitulatif des exigences d'installations particulières pour différentes applications est donné à l'Annexe AA informative.

7.12.101 Les instructions pour des applications dans des planchers en béton ou en matériaux similaires, y compris le béton ou matériaux similaires posés sur un plancher en bois, ou sous des dalles doivent fournir les indications suivantes:

- a) une grille doit être installée au-dessus de l'**unité chauffante**. La grille doit:
- être protégée contre la corrosion, mais ne doit pas être isolée électriquement;
 - être électriquement et mécaniquement équivalente à une grille en acier dont les mailles ne dépassent pas 50 mm x 50 mm et dont le diamètre du fil est de 1 mm, sauf si la grille couvre:
 - des **unités chauffantes de la classe II**;
 - des **unités chauffantes** installées avec une isolation électrique supplémentaire;
 - couvrir complètement l'**unité chauffante**, y compris les zones de fixation. Elle peut couvrir plusieurs **unités chauffantes**;
 - être raccordée à la terre;
 - être équipée de bornes appropriées au raccordement de deux conducteurs de 2,5 mm² de section nominale;
 - être vérifiée pour la continuité électrique pendant l'installation.

La grille n'est pas exigée pour les cas suivants:

- des **unités chauffantes de la classe III**;
 - les **unités chauffantes de la classe II** alimentées par l'intermédiaire d'un transformateur d'isolement;
 - les **unités chauffantes de classe II** installées dans des emplacements secs (des emplacements secs sont des zones situées à l'extérieur de la zone 3 définie dans l'IEC 60364-7-701) et alimentées par un dispositif à courant différentiel résiduel (DDR);
 - les **unités chauffantes installées** dans des emplacements secs (des emplacements secs sont des zones situées à l'extérieur de la zone 3 définie dans l'IEC 60364-7-701) si l'**isolation principale** et l'isolation électrique supplémentaire satisfont chacune à l'essai de rigidité diélectrique, pour l'**isolation renforcée**, décrit en 16.3;
 - les **unités chauffantes** qui comportent un écran ou une tresse métallique dont la résistance par unité de longueur est équivalente à celle d'un conducteur de cuivre de 0,5 mm²;
- b) lorsque les **unités chauffantes** ont été mises en place, elles doivent être recouvertes d'une couche de matériau supplémentaire pour la protection mécanique. Si les **unités chauffantes** sont placées sur du béton, un film similaire doit être inséré entre l'**unité chauffante** et le béton. Les couches de film adjacentes doivent se chevaucher et être fixées les unes aux autres. Le film doit recouvrir les murs jusqu'au niveau de la surface du béton. Ces indications ne sont pas exigées dans les cas suivants:
- si les fils chauffants isolés protégés sont recouverts d'une gaine conforme au 21.103;
 - si l'isolation électrique supplémentaire est conforme à l'essai décrit en 21.102;
- c) lorsque des **unités chauffantes** ne comportent qu'une **isolation principale**, autres que celles alimentées en **très basse tension de sécurité**, sont équipées d'un isolant électrique supplémentaire, cet isolant supplémentaire doit être placé directement sur l'**unité chauffante**;

- d) les **unités chauffantes de la classe II** doivent être installées à une distance d'au moins 30 mm de parties conductrices du bâtiment, telles que les canalisations d'eau.

7.12.102 Les instructions pour des applications dans des plafonds métalliques ou des planchers métalliques pour les **unités chauffantes** qui ne comportent qu'une **isolation principale**, autres que celles alimentées en **très basse tension de sécurité**, doivent fournir les indications suivantes:

- a) le **film souple chauffant** doit être totalement couvert par le plafond ou le plancher;
- b) les parties métalliques du plafond ou du plancher doivent être reliées à la terre. Les instructions doivent indiquer que les parties métalliques doivent être équipées de bornes de terre appropriées pour le raccordement de deux conducteurs de 2,5 mm² de section nominale et doivent expliquer comment le raccordement à la borne de terre doit être réalisé pour assurer une faible résistance. Les indications relatives à la nécessité de mise à la terre ne sont pas exigées s'il est indiqué qu'une couche d'isolation électrique supplémentaire doit être installée entre l'**unité chauffante** et le plafond. Si cet isolant n'est pas fourni, le nom du fabricant et la référence de l'isolant doivent être mentionnés.

7.12.103 Les instructions relatives aux applications sur les planchers lorsque les **unités chauffantes** doivent être couvertes par des dalles de revêtement doivent indiquer que les **unités chauffantes** doivent être couvertes par une isolation électrique supplémentaire, sauf si les **unités chauffantes** sont de la **classe I**, de la **classe II** ou de la **classe III**.

7.12.104 Les instructions concernant les **films souples chauffants** qui peuvent être découpés sur site doivent indiquer que ce travail doit être effectué uniquement par des personnes autorisées par le fabricant et doivent fournir des informations sur la manière de

- découper les films souples chauffants;
- protéger les bords des **films souples chauffants**;
- connecter les **conducteurs d'alimentation** aux conducteurs d'interconnexion, et isoler les connexions.

7.12.105 Les instructions concernant les **unités chauffantes** pour les **applications de chauffage à accumulation** doivent spécifier la **durée de charge assignée**.

7.12.106 Sauf si les **unités chauffantes**

- comportent un écran ou une tresse métallique dont la résistance par unité de longueur est équivalente à celle d'un conducteur de cuivre de 0,5 mm²; ou
- sont de la **classe III**; ou
- consistent en un matériau de base sur lequel sont fixés des conducteurs chauffants qui comportent un écran métallique, isolés électriquement et destinés à être utilisés dans des murs à une hauteur inférieure à 1,2 m,

leurs instructions doivent indiquer que les **unités chauffantes** doivent être du type de construction qui comporte un écran conducteur électrique. L'**unité chauffante** doit être installée de manière que l'écran soit orienté vers le matériau de revêtement.

Les instructions applicables aux **unités chauffantes** destinées à être utilisées dans des murs à une hauteur inférieure à 1,2 m et avec un écran conducteur électrique séparé doivent préciser que l'écran doit être placé entre le matériau de revêtement et l'**unité chauffante**.

Les instructions applicables aux **unités chauffantes** destinées à être utilisées dans des murs doivent préciser que l'**unité chauffante** doit être installée:

- à une hauteur comprise entre 0,2 m et 1,2 m au-dessus du plancher; ou
- à une hauteur supérieure à 2,3 m au-dessus du plancher.

Les instructions applicables aux **unités chauffantes** destinées à être utilisées dans des murs doivent comporter en substance les indications suivantes:

- l'écran doit être relié au conducteur de mise à la terre de l'installation fixe;
- si l'unité chauffante est installée sur une cloison interne à une distance entre les matériaux du mur inférieure à 50 mm, l'unité chauffante doit être installée de sorte que l'écran soit orienté vers le matériau de revêtement du mur, des deux côtés de l'unité chauffante.

Les instructions pour les **unités chauffantes** qui comportent un **circuit de protection amovible** doivent préciser les conditions d'installation.

7.14 *Modification:*

L'essai avec l'essence n'est pas effectué.

Addition:

Si des symboles sont utilisés en ce qui concerne le mode d'installation ou de chauffage prévu, le rectangle superposé doit avoir une hauteur d'au moins 15 mm.

7.15 *Modification:*

Seules les exigences concernant les interrupteurs et les dispositifs de commande s'appliquent.

7.101 Une étiquette assez grande pour indiquer les emplacements des **unités chauffantes** à énumérer par l'installateur doit être apposée pour chaque installation et préciser

- le nom, la marque commerciale ou la marque d'identification du fabricant ou du vendeur responsable;
- la référence du modèle ou du type.

L'étiquette doit comporter en substance les indications suivantes:

- des **films souples chauffants** sont installés dans le plafond, le mur ou le plancher, en fonction des cas;
- ne pas restreindre l'émission thermique du plafond, du mur ou du plancher chauffé, en fonction des cas;
- ne pas apposer de matériaux autres que ceux recommandés;
- ne pas introduire de clous ni de vis, ne pas percer ailleurs que dans les zones non chauffantes;
- cette étiquette doit être fixée sur le tableau de distribution qui alimente l'**unité chauffante**, ou être placée à proximité.

Si des **unités chauffantes** sont installées dans des murs à une hauteur inférieure à 1,2 m, l'étiquette doit indiquer les emplacements des zones non chauffantes ou des zones chauffantes.

La vérification est effectuée par examen.

8 Protection contre l'accès aux parties actives

L'article de la Partie 1 s'applique.

9 Démarrage des appareils à moteur

L'article de la Partie 1 ne s'applique pas.

10 Puissance et courant

L'article de la Partie 1 s'applique, avec l'exception suivante.

10.1 Addition:

L'exigence s'applique également à la **puissance assignée** par mètre de **films souples chauffants**.

11 Échauffements

L'article de la Partie 1 s'applique, avec les exceptions suivantes.

11.1 Addition:

Les essais sont effectués dans une pièce maintenue à une température ambiante de $20\text{ °C} \pm 2\text{ °C}$.

11.2 Remplacement:

Les **unités chauffantes** destinées à être installées dans des plafonds sont mises en place conformément au 11.2.101.

Les **unités chauffantes modulaires** pour les plafonds suspendus sont mises en place conformément au 11.2.102.

Les **unités chauffantes** destinées à être installées dans des planchers sont mises en place conformément au 11.2.103.

Les **unités chauffantes** séparées destinées à chauffer un plafond et le plancher qui est au-dessus de lui sont mises en place conformément au 11.2.104.

Les **unités chauffantes** destinées à être installées au-dessous de 1,2 m dans des murs en bois sont mises en place conformément au 11.2.105.

Les **unités chauffantes** séparées destinées à chauffer les deux côtés d'un mur en bois sont mises en place conformément au 11.2.106.

Les **unités chauffantes** destinées à être installées dans ou contre des murs en béton ou en matériaux similaires sont mises en place conformément au 11.2.107.

Si une **unité chauffante** est équipée d'un thermostat qui possède un capteur séparé, le capteur est situé sur l'axe de l'une des **unités chauffantes** adjacentes, à une distance minimale de 0,3 m à l'extérieur de la surface occupée par l'isolant thermique placé sur le plancher et à au moins 0,3 m du bord de la zone chauffante.

11.2.101 Les **unités chauffantes** destinées à être installées dans un plafond en bois sont placées dans une structure d'essai, comme cela est représenté à la Figure 101. Une zone d'une superficie supérieure ou égale à 4 m^2 , dont la plus petite dimension est supérieure ou égale à 2 m, est couverte d'au moins trois **unités chauffantes**, l'unité soumise à l'essai étant placée au milieu. Les **unités chauffantes** sont installées conformément aux instructions d'installation, en attirant l'attention sur l'emplacement dans lequel elles peuvent être situées sous des parties de structures en bois telles que les entretoises. La face supérieure des **unités chauffantes** est totalement couverte par une couche d'isolant thermique dont la résistance thermique est d'environ $5\text{ m}^2\text{K/W}$. La face inférieure des **unités chauffantes** est couverte du matériau le plus défavorable cité dans les instructions d'installation.

La structure d'essai est suspendue de manière qu'il existe un espace d'une hauteur d'environ 0,3 m au-dessus de sa surface supérieure et d'au moins 1,5 m au-dessous de la surface inférieure. La structure d'essai est entourée par des planches en bois qui se prolongent d'environ 0,2 m sous sa surface inférieure.

Si les instructions d'installation permettent l'utilisation de planches en gypse comme matériau de recouvrement, un essai supplémentaire est effectué avec ce matériau.

Les **unités chauffantes** destinées à être installées dans un plafond métallique sont installées conformément aux instructions.

11.2.102 Neuf **unités chauffantes modulaires** sont installées conformément aux instructions. Elles sont disposées dans une matrice trois par trois, l'**unité chauffante** soumise à l'essai étant située au centre, comme cela est représenté à la Figure 102. Cependant, si une dimension de la matrice est inférieure à 1,8 m, des **unités chauffantes** supplémentaires sont installées. La face supérieure de la matrice est totalement couverte d'une couche d'isolant thermique de sorte que la résistance thermique totale au-dessus des **films souples chauffants** soit d'environ $5 \text{ m}^2\text{K/W}$. L'isolant est mis en place de manière à être en contact parfait avec les faces supérieures des **unités chauffantes**.

La structure d'essai est suspendue de manière à laisser un espace d'une hauteur d'environ 0,3 m au-dessus de sa face supérieure et d'au moins 1,5 m au-dessous de sa surface inférieure. La structure d'essai est entourée de planches de bois qui se prolongent d'environ 0,2 m sous sa face inférieure et jusqu'au plafond de la pièce.

11.2.103 Les **unités chauffantes** destinées à être installées dans un plancher en bois sont placées dans une structure d'essai, comme cela est représenté à la Figure 103. Les **unités chauffantes** destinées à être installées au-dessus d'un plancher en bois sont placées dans une structure d'essai, comme cela est représenté à la Figure 104. Une zone d'une superficie supérieure ou égale à 4 m^2 , dont la plus petite dimension est supérieure ou égale à 2 m, est couverte d'au moins trois **unités chauffantes**, l'unité soumise à l'essai étant placée au milieu. Un isolant thermique dont la résistance thermique est d'environ $5 \text{ m}^2\text{K/W}$ est situé sous les **unités chauffantes**. Les **unités chauffantes** sont installées conformément aux instructions d'installation, en attirant l'attention sur l'emplacement dans lequel elles peuvent être situées sous des parties de structures en bois telles que les entretoises. La face supérieure de la structure est couverte du plancher le plus défavorable du point de vue de la résistance thermique totale conformément aux instructions d'installation, un espace étant maintenu comme cela est représenté sur les figures, si les instructions le spécifient.

Deux espaces libres sont ménagés autour de la structure d'essai, l'un d'au moins 0,1 m au-dessous de sa face inférieure et l'autre d'au moins 1,5 m au-dessus de sa face supérieure. La structure d'essai est entourée de planches de bois qui se prolongent d'au moins 1 m au-dessus de sa face supérieure.

Une pièce d'isolant thermique dont la résistance thermique est d'environ $1,25 \text{ m}^2\text{K/W}$ est placée sur le plancher en travers des **unités chauffantes**, en leur centre, comme cela est représenté sur la Figure 103 et la Figure 104. Sa longueur est de 0,8 m et sa largeur est égale à celle de l'**unité chauffante**.

Les **unités chauffantes** destinées à être installées dans un plancher en béton ou en matériaux similaires sont placées comme cela est représenté à la Figure 105. Les **unités chauffantes** destinées à être installées au-dessus d'un plancher en béton ou en matériaux similaires sont placées comme cela est représenté à la Figure 106. Les **unités chauffantes** sont installées conformément aux instructions d'installation, tout isolant électrique supplémentaire spécifié étant placé au-dessus d'elles. Une zone d'une superficie supérieure ou égale à 4 m², dont la plus petite dimension est supérieure ou égale à 2 m, est couverte d'au moins trois **unités chauffantes**, l'unité soumise à l'essai étant placée au milieu. Un isolant thermique dont la résistance thermique est d'environ 2,5 m²K/W est situé sous les **unités chauffantes**. Pour les **unités chauffantes** destinées à être installées dans le béton ou dans des matériaux similaires, l'isolant thermique est supporté par un panneau de contre-plaqué peint en noir mat d'environ 20 mm d'épaisseur.

Les **unités chauffantes** sont couvertes de la couche supplémentaire si les instructions le spécifient. Elles sont ensuite couvertes d'une couche de béton d'environ 40 mm d'épaisseur ou de l'épaisseur indiquée dans les instructions, si cette valeur est plus élevée. Au lieu de couler du béton, la couche de béton peut être constituée de dalles d'une épaisseur de 40 mm et de dimensions d'au moins 500 mm × 500 mm, les espaces entre les dalles étant remplis de sable sec. Si l'**unité chauffante** est prévue pour une **application de chauffage à accumulation**, l'épaisseur du béton est de 80 mm. La couche de béton n'est pas appliquée pour les **unités chauffantes** destinées à être installées sur un sol en béton. Une grille est incluse dans le dispositif d'essai si cela est spécifié. Le plancher est recouvert du matériau de revêtement de sol le plus défavorable indiqué dans les instructions d'installation. Un espace libre d'au moins 1,5 m est ménagé au-dessus du sol.

L'isolation thermique peut être utilisée à la place pour représenter le matériau de revêtement de sol le plus défavorable.

Une pièce d'isolant thermique dont la résistance thermique est d'environ 1,25 m²K/W est placée sur le plancher en travers des **unités chauffantes**, en leur centre, comme cela est représenté sur la Figure 105 et la Figure 106. Sa longueur est de 0,8 m et sa largeur est égale à celle de l'**unité chauffante**.

Une partie de l'épaisseur de béton peut être remplacée par du sable à condition que la résistance thermique soit maintenue.

Les espaces dans le sol et entre les dalles de béton doivent être réduits le plus possible.

Pour mesurer l'échauffement le plus élevé du sol, il peut être nécessaire de répéter l'essai avec le matériau de revêtement qui possède l'épaisseur minimale spécifiée dans les instructions.

Les **unités chauffantes** destinées à être installées dans des planchers métalliques sont installées conformément aux instructions.

11.2.104 Les **unités chauffantes** séparées, destinées à chauffer un plancher en bois et le plafond qui est au-dessous de lui, sont installées dans une structure d'essai, comme cela est représenté à la Figure 107, conformément aux instructions. Une zone d'au moins 4 m², dont la plus petite dimension est d'au moins 2,0 m, est couverte de deux jeux d'au moins trois **unités chauffantes** séparées par un isolant thermique. Les **unités chauffantes** soumises à l'essai sont placées au milieu, l'une au-dessus de l'autre. L'isolant a une résistance thermique d'environ 1,45 m² K/W, sauf si une valeur inférieure est spécifiée dans les instructions. Les autres détails concernant la disposition sont spécifiés en 11.2.101 et 11.2.103 pour les constructions en bois.

11.2.105 Les **unités chauffantes** destinées à être installées au-dessous de 1,2 m dans des murs en bois sont placées dans une structure d'essai, comme cela est représenté à la Figure 108. Une zone d'une superficie supérieure ou égale à 4 m², dont la plus petite dimension est supérieure ou égale à 2 m, est couverte d'au moins trois **unités chauffantes**, l'unité soumise à l'essai étant placée au milieu. Les **unités chauffantes** sont installées conformément aux instructions d'installation, en attirant l'attention sur l'emplacement dans lequel elles peuvent être situées sous des parties de structures en bois telles que les entretoises.

Le côté des **unités chauffantes** orienté vers la pièce à chauffer est couvert du matériau de revêtement le plus défavorable cité dans les instructions d'installation. Le côté sans **unité chauffante** est totalement couvert par une couche d'isolant thermique ayant une résistance thermique d'environ 5 m² K/W, maintenue contre l'**unité chauffante** conformément aux instructions d'installation.

Un matériau de recouvrement est ajouté, même sur le côté du mur sans **unité chauffante**. Il ne doit y avoir aucun espace entre le matériau de recouvrement et l'isolant thermique.

La structure d'essai est placée de manière qu'il existe un espace d'une largeur d'environ 0,3 m à partir de sa surface non chauffée et d'au moins 1,5 m à partir de la surface à chauffer. La structure d'essai est entourée par des planches en bois qui dépassent le matériau de recouvrement d'environ 0,2 m.

Une pièce d'isolant thermique dont la résistance thermique est d'environ 1,25 m² K/W est placée contre le mur en direction de la pièce, en travers des **unités chauffantes**, en leur centre, comme cela est représenté à la Figure 108. Sa longueur est de 0,8 m et sa largeur est égale à celle de l'**unité chauffante**.

Si les instructions d'installation permettent l'utilisation de planches en gypse comme matériau de recouvrement, un essai supplémentaire est effectué avec ce matériau.

Les **unités chauffantes** destinées à être installées dans un mur métallique sont installées conformément aux instructions.

11.2.106 Les **unités chauffantes** séparées, destinées à chauffer les deux côtés d'un mur en bois, sont installées dans une structure d'essai, comme cela est représenté à la Figure 109, conformément aux instructions. Une zone d'au moins 4 m², dont la plus petite dimension est d'au moins 2,0 m, est couverte de deux jeux d'au moins trois **unités chauffantes** séparées par un isolant thermique. Les **unités chauffantes** soumises à l'essai sont placées au milieu, l'une à l'opposé de l'autre. L'isolant a une résistance thermique d'environ 1,45 m² K/W, sauf si une valeur inférieure est spécifiée dans les instructions. La structure d'essai est entourée par des planches en bois qui dépassent le matériau de recouvrement d'environ 0,2 m. Les autres détails concernant la disposition sont spécifiés en 11.2.101 et 11.2.103 pour les constructions en bois.

Une pièce d'isolant thermique dont la résistance thermique est d'environ 0,9 m² K/W est placée contre l'un des murs, en travers des **unités chauffantes**, en leur centre, comme cela est représenté à la Figure 109. Sa longueur est de 0,8 m et sa largeur est égale à celle de l'**unité chauffante**.

11.2.107 Les **unités chauffantes** destinées à être installées dans un mur en béton ou en matériaux similaires sont placées comme cela est représenté à la Figure 110. Les **unités chauffantes** destinées à être installées contre un mur en béton ou en matériaux similaires sont placées comme cela est représenté à la Figure 111. Les **unités chauffantes** sont installées conformément aux instructions d'installation, tout isolant électrique supplémentaire spécifié étant placé contre elles. Une zone d'une superficie supérieure ou égale à 4 m², dont la plus petite dimension est supérieure ou égale à 2 m, est couverte d'au moins trois **unités chauffantes**, l'unité soumise à l'essai étant placée au milieu. Un isolant thermique ayant une résistance thermique d'environ 2,5 m²K/W est situé à l'arrière des **unités chauffantes**. Pour les **unités chauffantes** destinées à être installées dans le béton ou dans des matériaux similaires, l'isolant thermique est supporté par un panneau de contre-plaqué peint en noir mat d'environ 20 mm d'épaisseur.

Les **unités chauffantes** sont couvertes de la couche supplémentaire si les instructions le spécifient. Elles sont ensuite couvertes d'une couche de béton d'environ 40 mm d'épaisseur ou de l'épaisseur indiquée dans les instructions, si cette valeur est plus élevée. Au lieu de couler du béton, la couche de béton peut être constituée de dalles d'une épaisseur de 40 mm et de dimensions d'au moins 500 mm × 500 mm, les espaces entre les dalles étant remplis de béton fin. Si l'**unité chauffante** est prévue pour une **application de chauffage à accumulation**, l'épaisseur du béton est portée à 80 mm. La couche de béton n'est pas appliquée pour les **unités chauffantes** destinées à être installées contre un mur en béton. Une grille est incluse dans le dispositif d'essai si cela est spécifié. Le mur est recouvert du matériau de revêtement de sol le plus défavorable indiqué dans les instructions d'installation. Un espace libre d'au moins 1,5 m est ménagé à partir du mur. La structure d'essai est entourée par des planches en bois qui dépassent le matériau de recouvrement d'environ 0,2 m.

Les espaces dans le mur et entre les dalles de béton doivent être réduits le plus possible.

11.7 Modification:

Remplacer le premier alinéa par ce qui suit:

Les **unités chauffantes** sont mises en fonctionnement jusqu'à établissement des conditions de régime.

Les **unités chauffantes** pour les **applications de chauffage à accumulation** sont mises en fonctionnement comme cela est spécifié pour les conditions de **fonctionnement normal** ou jusqu'au premier fonctionnement du dispositif de commande de charge si celui-ci intervient en premier.

11.8 Addition

Les échauffements des surfaces ne doivent pas dépasser les valeurs indiquées dans le Tableau 101.