IEC 60335-2-110

Edition 2.0 2024-07
REDLINE VERSION

INTERNATIONAL STANDARD

colour inside

Household and similar electrical appliances – Safety –
Part 2-110: Particular requirements for commercial microwave appliances with insertion or contacting applicators

IEC 60335-2-110:2024-07 RLV(en)

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CONTENTS

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HOUSEHOLD AND SIMILAR ELECTRICAL APPLIANCES – SAFETY –

Part 2-110: Particular requirements for commercial microwave appliances with insertion or contacting applicators

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This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 60335-2-110:2013+AMD1:2019 CSV. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

IEC 60335-2-110 has been prepared by subcommittee 61B: Safety of microwave appliances for household and commercial use, of IEC technical committee 61: Safety of household and similar electrical appliances. It is an International Standard.

This second edition cancels and replaces the first edition published in 2013 and Amendment 1:2019. This edition constitutes a technical revision.

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

– Subclause 7.1 has been improved in clarity.
– Subclauses 19.11.2 and 19.103 have been improved in clarity.
– Clause 28 has been modified to add screw requirements.

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

Draft	Report on voting
61B/688/CDV	61B/691A/RVC

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 commercial microwave appliances with insertion or contacting applicators.

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

NOTE 2 The following numbering system is used:

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

NOTE 3 The following print types are used:

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

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

The committee has decided that the contents of this 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 and SC 61B supporting documents on the IEC website
https://www.iec.ch/tc61/supportingdocuments
https://www.iec.ch/sc61b/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.~~

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 2-110: Particular requirements for commercial microwave appliances with insertion or contacting applicators

1 Scope

This clause of Part 1 is replaced by the following.

This part of IEC 60335 deals with the safety of microwave appliances intended for commercial use, their **rated voltage** being not more than 250 V for single-phase appliances connected between one phase and neutral and 480 V for other appliances.

~~In general, this standard does not take into account~~

~~– persons (including children) whose~~

~~• physical, sensory or mental capabilities; or~~

~~• lack of experience and knowledge~~

~~prevents them from using the appliance safely without supervision or instruction;~~

~~– children playing with the appliance.~~

As far as is practicable, this standard deals with the common hazards presented by these types of appliances.

Appliances covered by this standard incorporate an open-ended **applicator** (as example an overview is given in Figure 103) for treatment of the **load**. They are divided into three types:

– with **insertion applicator**, typically for moisture removal by insertion into holes in floors, walls or ceilings (an example is given in Figure 106);
– with **large area contacting applicator**, typically for drying of floors, walls or ceilings (examples are given in Figure 104 and Figure 105);
– with **small area contacting applicator**, typically for paint removal and spot-heating (an example is given in Figure 107).

Microwave appliances with **insertion applicator**, **large area contacting applicator** or **small area contacting applicator** are using electromagnetic energy in one or several of the ISM frequency bands between 300 MHz and 30 GHz, for supplying energy to an external load which is heated so that a resulting process of drying, moisture transport which can result in forces due to formation of steam, decomposition or chemical modification, melting, or termination of organisms such as bacteria or fungus occurs.

NOTE 101 ISM frequency bands are the electromagnetic frequencies established by the ITU and reproduced in CISPR 11.

NOTE 102 Food and beverages are not loads in the meaning of this standard.

~~NOTE 101~~ Appliances with **insertion applicator** and with **large area contacting applicator** are **portable appliances**. Appliances with **small area contacting applicator** are **handheld appliances**.

~~NOTE 102~~ Appliances that use non-electrical energy are within the scope of this standard. The microwave-related portion is considered **motor-operated**.

The rationales for the **microwave barrier** and associated leakage tests are described in informative Annex AA.

~~NOTE 103~~ Attention is drawn to the fact that

– these appliances can radiate microwave energy outside a **restricted area** where they are used. The additional requirements specified by national authorities responsible for the protection for non-ionising radiation that the limit of power flux density is 10 W/m^2, averaged over any time period of 6 min, outside this **restricted area** is taken into consideration in this standard;

– these appliances are intended to exclusively treat the **load** in **normal operation**, i.e. this standard does not apply to appliances or systems employing free space microwave propagation;

– for appliances intended to be used in tropical countries, special requirements can be necessary;

– in many countries, additional requirements are specified by the national health authorities, and national authorities responsible for the protection of labour and for non-ionising radiation protection.

~~NOTE 104~~ This standard does not apply to

– household microwave ovens, including combination microwave ovens (IEC 60335-2-25);

– commercial microwave ovens with a cavity door, commercial combination microwave ovens with a cavity door and commercial microwave ovens without a cavity door and with transportation means (IEC 60335-2-90);

– industrial microwave heating equipment (IEC 60519-6);

– appliances for medical purposes (IEC 60601-1);

– appliances and equipment for laboratory use (IEC 61010 series);

– appliances intended to be used in locations where special conditions prevail, such as the presence of a corrosive or explosive atmosphere (dust, vapour or gas);

~~NOTE 105~~ Some of the specifications and tests in this standard are not applicable for other than 2 450 MHz appliances.

2 Normative references

This clause of Part 1 is applicable except as follows.

Addition:

IEC 60335-2-90, *Household and similar electrical appliances – Safety – Part 2-90: Particular requirements for commercial microwave ovens*

ISO 898-1, *Mechanical properties of fasteners made of carbon steel and alloy steel – Part 1: Bolts, screws and studs with specified property classes – Coarse thread and fine pitch thread*

ISO 3506-1, *Fasteners − Mechanical properties of corrosion-resistant stainless steel fasteners − Part 1: Bolts, screws and studs with specified grades and property classes*

ISO 3506-2, *Fasteners − Mechanical properties of corrosion-resistant stainless steel fasteners − Part 2: Nuts with specified grades and property classes*

ISO 3506-3, *Mechanical properties of corrosion-resistant stainless steel fasteners – Part 3: Set screws and similar fasteners not under tensile stress*

ISO 3506-4, *Mechanical properties of corrosion-resistant stainless steel fasteners – Part 4: Tapping screws*

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

ISO 7010, *Graphical symbols – Safety colours and safety signs – Registered safety signs*

3 Terms and definitions

This clause of Part 1 is applicable except as follows.

3.1 Definitions relating to physical characteristics

3.1.7

Note 101 to entry: The **rated frequency** is the input frequency.

3.1.9

Modification:

~~**normal operation**~~

Replace the first paragraph by the following.

heating operation of the **appliance** under the following conditions:

The **appliance** is operated according to the manufacturer's instructions for **intended use**. However, using a typical **load** for **intended use** ~~may~~ can be impractical, since it ~~may~~ can be part of a building, unless the manufacturer makes useful and realistic such **loads** available for the tests. If that is not the case, the appliance is operated under the following conditions:

The initial temperature of the test **load** which is used for microwave energy absorption shall be (20 ± 5) °C.

The highest generator power settings are to be used.

Appliances with an **insertion applicator** for moisture removal are operated by insertion into holes in floor, wall or ceiling structures under the following conditions:

a) The test **load** consists of a metal tank filled with water, having an open top water surface exceeding that of the horizontal dimensions of the appliance by at least 70 mm on all sides and having a water column height of at least 150 mm plus the length of the longest insertion distance of the **insertion applicator**. At the top sides of the tank there are horizontal supports of a **microwave-transparent** material, with a suitable opening for the applicator antenna. The water level is adjusted so that the distance from the housing of the appliance to the test **load** is the same as in its **intended use**.

   Note 101 to entry: If it is obvious that good microwave impedance matching of the **insertion applicator** can be obtained only if the hole into which it is inserted is not water-filled, a sleeve or similar of a highly **microwave transparent** material such as PTFE is used around the **insertion applicator**. If wave propagation in the axial direction occurs in the test set-up and the manufacturer can show that it is not possible in actual use, or monitoring devices then shut down the **insertion applicator**, a thin-wall plastic tube with inner diameter corresponding to the maximum hole diameter according to the manufacturer's specification can be used.

b) Appliances with **large area contacting applicator** for drying of floor, wall or ceiling structures are operated under the following conditions: the test **load** consists of a metal tank filled with water, having an open top water surface exceeding that of the horizontal dimensions of the appliance by at least 70 mm on all sides and having a water column height of at least 150 mm. At the top of two opposite tank sides there are horizontal supports of a **microwave-transparent** material, extending just so far inwards that the **traction drive** rests on the support. The water level is adjusted so that the distance from the **applicator** to the test **load** is the same as in its **intended use**. The proper reversal function of the **traction drive** is tested under the following conditions: the appliance is operated on a horizontal

plywood surface with a thickness of 20 mm and an area sufficient to allow back and forth movement between blocks representing walls.

Note 102 to entry: If needed for representative operation of the appliance, the horizontal supports are extended as to activate the mechanical **microwave interlocks**.

Appliances with **small area contacting applicator** for paint removal and spot-heating are operated under the following conditions:

The test **load** consists of a grinding wheel or grinding block made of fine-grained silicon carbide at least 15 mm in thickness, and its length and width exceeding the corresponding dimensions of the **applicator** opening by at least 30 mm; however this test **load** shall be so large that it can be air-cooled from the underside without the appliance being influenced.

~~**3.101**~~
~~**microwave appliance with insertion, large or small area contacting applicator**~~
~~commercial appliance using electromagnetic energy in one or several of the ISM frequency bands between 300 MHz and 30 GHz, for supplying energy to an external **load** which is heated so that a resulting process of drying, moisture transport which may result in forces due to formation of steam, decomposition or chemical modification, melting, or termination of organisms such as bacteria or fungus occurs~~

~~Note 1 to entry: ISM frequency bands are the electromagnetic frequencies established by the ITU and reproduced in CISPR 11.~~

~~Note 2 to entry: Food and beverages are not **loads** in the meaning of this standard.~~

~~**3.108**~~**3.1.101**
rated microwave power output
microwave power output assigned to the appliance by the manufacturer

Note 1 to entry: This can be lower than the **available microwave power**, due to intentional microwave power losses in microwave absorbers (see Note in 101.1) and coaxial cables acting for protection of the microwave generator of **small area contacting applicators** (see 22.101).

~~**3.109**~~**3.1.102**
available microwave power
microwave generator nominal output under impedance matched condition which is obtained by the generator manufacturer specification and measurement of its electrical input to the generator in the appliance during the first 10 s of operation at maximum power

Note 1 to entry: Magnetrons will typically have a stationary power output 3 s after energising.

3.6 Definitions relating to parts of an appliance

~~**3.102**~~**3.6.101**
applicator
structure which applies the microwave energy to the **load**

~~**3.104**~~**3.6.102**
microwave ~~transparency~~ transparent
property of a material having negligible absorption and reflection of microwaves

Note 1 to entry: The relative permittivity of a **microwave transparent** material is less than 7 and the relative loss factor is less than 0,015.

~~**3.105**~~**3.6.103**
insertion applicator
applicator for insertion into the **load**, in which all **available microwave power** is intended to be absorbed

~~3.106~~3.6.104
large area contacting applicator
applicator with a metallic enclosure, having at least one geometric non-metallic opening through which microwave energy is applied to a closely located external **load** in which all **available microwave power** is intended to be absorbed

~~3.107~~3.6.105
small area contacting applicator
applicator with a metallic enclosure, having at least one geometric non-metallic opening or appropriate device through which microwave energy is applied to a very closely located external **load** in which all **rated microwave power** is intended to be absorbed

~~3.113~~3.6.106
traction drive
means or system used to accomplish movement of an appliance with **large area contacting applicator** on a floor

~~3.114~~3.6.107
microwave enclosure
overall structure that is intended to confine the microwave energy

Note 1 to entry: Barriers mounted outside the **microwave enclosure** are not considered a part of it.

~~3.115~~3.6.108
microwave barrier
microwave transparent part of the microwave appliance that is mounted outside the **microwave enclosure** for limiting access into it and can only be removed with the aid of **tools**

Note 1 to entry: A **microwave barrier** can be mounted between the **microwave enclosure** and the external cover of the appliance.

Note 2 to entry: Devices such as an array of metal chains or hinged metal plates at the periphery of the opening of an **applicator** intended to reduce microwave leakage are not considered **microwave barriers**.

Note 3 to entry: **Microwave barriers** cannot be hinged or flexed.

~~3.116~~3.6.109
microwave guard
constructive part of the appliance that is mounted outside or at the **microwave enclosure** for reducing microwave leakage by shielding and/or absorption and can only be removed with the aid of **tools**

Note 1 to entry: **Microwave guards** can move or open when the **applicator** is brought into contact with the **load**.

Note 2 to entry: Devices such as an array of metal chains or hinged metal plates at the periphery of the opening of an **applicator** intended to reduce microwave leakage are considered **microwave guards**.

~~3.117~~3.6.110
maintenance door
constructive part of the appliance that can be opened or removed with the aid of **tools** to get access for service and repair

~~3.118~~3.6.111
microwave interlock
device or system that prevents the operation of the microwave generator if conditions of ~~excessive~~ microwave leakage occur or are likely to occur

Note 1 to entry: Examples of **microwave interlock** are switches which stop the microwave power when a contacting **applicator** is lifted up or an **insertion applicator** is removed from its **load** during operation, and an integral leakage monitor which does the same if there is insufficient proximity between an **applicator** and the **load** or if an attempt is made to start the appliance without a **load**.

~~3.121~~3.6.112
viewing opening
opening into the **applicator** through which the treatment can be visually monitored

3.8 Definitions relating to miscellaneous matters

~~3.103~~3.8.101
load
object to be treated into which the **applicator** is introduced or put in close position to

~~3.110~~3.8.102
instructed person
person who is ~~sufficiently~~ instructed and monitored to know how to avoid any danger caused by the operation of a microwave appliance with **insertion applicator**, **large area contacting applicator**, or **small area contacting applicator**

~~3.111~~3.8.103
skilled person
person with ~~suitable~~ professional education, knowledge and experience to discern and to avoid any danger caused by the operation of a microwave appliance with **insertion applicator**, **large area contacting applicator**, or **small area contacting applicator**

~~3.112~~3.8.104
ordinary person
person who is neither a **skilled person** nor an **instructed person**

~~3.119~~3.8.105
intended use
any use of the appliance which is ~~reasonably~~ foreseeable, as described in the user instructions, and which is consistent with such activities as operating, starting, stopping, connecting to or disconnecting from the supply mains

~~3.120~~3.8.106
user control
any **control** device requiring the operator's actuation to perform specific functions

~~3.122~~3.8.107
restricted area
space where the operation of the equipment takes place, plus any area outside this where the exposure level from the equipment ~~may exceed~~ exceeds 10 W/m^2, averaged over any 6 min

Note 1 to entry: The **restricted area** is determined by measuring the microwave leakage through floor, wall or ceiling structures of the treatment zone. The thickness of the **load** in the radially outgoing direction from the **applicator** is considered only if the **load** is accessible from behind for microwave leakage measurements in **normal operation**.

~~3.123~~3.8.108
biased-off switch
switch that automatically returns to the **off-position** when its actuating member is released

~~3.124~~3.8.109
start switch
biased-off switch that shall be actuated by the operator before the **operation switch** will function

~~3.125~~3.8.110
operation switch
biased-off switch designed so that it will automatically disconnect the microwave generator or the supply main circuit when the operator's actuating force is removed

4 General requirement

This clause of Part 1 is applicable except as follows.

4.101 Instead of the requirements on supervision of the **microwave interlocks** by monitored **microwave interlocks** as in IEC 60335-2-90, this standard applies the concepts of **restricted area** and microwave leakage checks of **microwave interlock** function for **large area contacting applicators** and **insertion applicators** – and **start switch** as well as **operation switch** for **small area contacting applicators**.

5 General conditions for the tests

This clause of Part 1 is applicable except as follows.

5.3 *Modification:*

Instead of carrying out the tests in the order of clauses, the following sequence of clauses and subclauses applies: Clause 32, 22.107, Clause 101, Clauses 7 to 17, Clause 20, Clause 21, Clause 18, Clause 19, Clause 22 (except 22.107), Clauses 23 to 31.

NOTE 101 Clause 101 deals with the protection against leakage by basic design of **microwave enclosures**; Clause 22 deals with the additional requirements applicable when handling and against improper handling of the appliance, and against other hazards caused by the microwaves; 32.1 deals with the leakage measurement instrumentation and handling, plus limiting values.

5.101 The microwave-related portion of the appliance is considered **motor-operated**.

6 Classification

This clause of Part 1 is applicable except as follows.

6.1 *Modification:*

Microwave appliances shall be **class I**.

6.2 *Addition:*

Large area contacting applicators and **insertion applicators** shall be at least IPX1. **Small area contacting applicators** shall be at least IPX5.

7 Marking and instructions

This clause of Part 1 is applicable except as follows.

7.1

Modification:

Add the following new dashed item and text before the last dashed item of the first list of Part 1:

– substance of the following warnings, if applicable:

- WARNING: Switch off and remove plug from mains before adjusting, cleaning or if the cord is entangled or damaged.
- ~~WARNING: Read the instruction sheet.~~

- WARNING: Keep the flexible supply cord away from the microwave-energised parts.

Addition:

Where appropriate IEC/ISO symbols or pictograms are available, they ~~may~~ can be used.

Modification:

Add the following new text before the compliance paragraph:

Where appropriate, appliances shall be marked with symbols ISO 7000-0434A (2004-01) and IEC 60417-6167 (2012-07).

Appliances shall be marked with the nominal frequency in megahertz of the ISM band in which they operate.

Appliances shall be marked with the **rated microwave power output**.

Appliances shall be marked on an affixed inspection tag or ~~similar~~ label, with the date when the latest complying microwave leakage and function test in accordance with the service manual was carried out.

Compliance is checked by inspection.

7.6 *Addition:*

	[symbol IEC 60417-6166 (2012-07)]	caution, non-ionizing electromagnetic radiation; caution, microwave radiation
	[symbol IEC 60417-6167 (2012-07)]	keep out of microwave radiation
	[symbol ISO 7010-P004 (2011-05)]	no thoroughfare

7.12 *Addition:*

The instructions shall include the substance of the following.

– WARNING: If **microwave barriers** or **microwave guards** are damaged, the appliance must not be operated until repairs by a **skilled person** have been carried out;

– WARNING: It is hazardous for anyone other than a **skilled person** to carry out any service or repair operation that involves the removal of any cover or barrier which gives protection against exposure to microwave energy;

– if smoke is observed, switch off or unplug the appliance;

– failure to maintain the appliance in a clean condition could lead to deterioration that could adversely affect the life of the appliance and possibly result in a hazardous situation;

– the appliance shall not be cleaned with a water jet.

Appliances shall be operated only by **instructed persons** or **skilled persons**.

An instruction sheet shall be supplied with the appliance.

The instructions shall include:

a) those warnings required to be marked on the appliance together with further explanation, where appropriate;

b) specifications of the load surface irregularities (non-flatness) with which the appliance may be used;

c) that the appliance shall not be used in standing water;

d) advice on the use and type of extension cords to be used (not lighter than required in 25.7);

e) instructions for fitting and use of attachments, if any;

f) the substance of the following, where appropriate:

WARNING: If parts of **viewing openings**, **microwave barriers**, **microwave guards**, the housing or any other means named by the manufacturer are damaged, the appliance shall not be operated until it is repaired by a **skilled person**. Until repairs are carried out, the appliance shall be set in a permanent non-operational condition (e.g. with key switch, code-card or similar devices). Further details are included in the instructions for use.

The **instructed persons** shall regularly, but at a minimum of once a year, be instructed by a **skilled person**. A record of the instruction provided shall be required.

1) Training

- Read the instructions ~~carefully~~. Be familiar with the **user controls** and the ~~proper~~ use of the appliance.
- Never allow ~~people unfamiliar with these instructions~~ **non-instructed persons** to use the appliance.

2) Preparation

- ~~Thoroughly inspect the area~~ Inspect all areas where the appliance is to be used and remove all foreign objects.

3) Operation

- Operate the appliance only in daylight or in good artificial light.
- The main switch key shall not be left with the appliance when it is unattended.
- The key shall be stored in a safe place.
- Use extreme caution when reversing or pulling an operating **insertion applicator** or **large area contacting applicator** towards you.
- Overheating of potentially flammable **loads** such as wood and some composite materials ~~may~~ can be locally and internally heated to charring, which ~~may~~ can in turn cause the microwave absorption rate to increase so that a fire occurs. The microwave power setting ~~may need~~ needs to be reduced and the treatment shall be constantly attended. Attention shall also be paid to the risk of a delayed hazardous condition.
- If smoke is observed, switch off the appliance, contain the fire by an extinguisher, pay attention to the risk of recurrence and see to it that the overheated region does not expand to unattended spaces.
- Never operate the appliance with defective **microwave barriers** or **microwave guards**, or without other safety devices in place.
- Switch on the appliance according to instructions and with all parts of your body which are not used for ~~correct~~ handling of the appliance well away from the **applicator**.
- Do not put hands or feet near or under **applicators**, **microwave barriers** or **microwave guards**.

- Pull the plug from the socket:
  - before clearing a blockage;
  - before checking, cleaning or working on the appliance;
  - after striking a foreign object. Inspect the appliance and, if damaged, do not operate it until it has been repaired by a **skilled person**.

7.14 *Addition:*

The warnings specified in 7.12 shall be in lettering at least 3 mm high.

The warnings specified in 7.101 and 7.102 shall be in lettering at least 5 mm high.

The letters of the substance of the warnings of the penultimate dashed item of the first list of 7.1, which ~~may~~ can be in upper or lower case, shall be a minimum of 5 mm high, in black on a yellow background.

The height of the triangle of symbol ISO 7000-0434A (2004-01) and the height of symbol IEC 60417-6167 (2012-07) shall be at least 50 mm.

The diameter of symbol ISO 7010-P004 (2011-05) and the height of the triangle of symbol IEC 60417-6166 (2012-07) required by 7.102 shall be at least 150 mm.

Symbols ISO 7000-0434A (2004-01), IEC 60417-6166 (2012-07) and ISO 7010-P004 (2011-05) shall comply with ISO 3864-1, but only with the specified colour requirements.

7.15 *Addition:*

The substance of the warnings of the penultimate dashed item of the first list of 7.1 shall be placed in a prominent position on the appliance.

Symbol ISO 7000-0434A (2004-01) and symbol IEC 60417-6167 (2012-07) shall be placed adjacent to each other in a location where any **microwave barrier** or **microwave guard** is visible, or near the opening in the **microwave barrier** of a **contacting applicator** under which there is a **load**.

The same symbols shall be placed at **viewing openings** with holes larger than diameter 12 mm and which are not protected by visually transparent protective devices.

Markings or symbols giving cautionary information shall be located close to the hazard.

7.101 The service or repair manual shall include the substance of the following:

– WARNING: The appliance shall comply with requirements of Clause 101 and 32.1 after every repair and according to the instructions of the manufacturer.

Attention: Persons shall not be exposed to excessive emitted microwave energy from the microwave generator. All connections, waveguides, flanges, seals, contacts, etc. of the **applicator**, **microwave enclosure**, **microwave barriers** and **microwave guards** shall be safely constructed so that the microwave leakage does not exceed the allowed limit. Operation of the appliance without a microwave absorbing **load** shall be avoided. The appliance shall be regularly maintained and kept in a good condition to ensure that microwave leakage does not exceed the allowed limit.

In addition, the service manual shall specify the following:

– the presence of user instructions is to be checked;

– a microwave leakage check is to be made at least every 100 h of usage or at shorter intervals, which shall be stated in the service manual;

– when the microwave leakage check is made, all **microwave interlocks** are to be checked and a test of the proper function of any built-in leakage monitor being a part of a **microwave interlock** is also made according to instructions which shall be given in the service manual;

– that the appliance shall be marked on an affixed inspection tag or ~~similar~~ label, with the date when the latest complying microwave leakage and function test in accordance with the paragraph above was carried out.

NOTE A test of a built-in leakage monitor can be made firstly by disabling its 20 s time constant, then making other **microwave interlocks** inoperable and then finally slowly lifting the **large area contacting applicator** during **normal operation**. **Insertion applicators** are tested in the same manner.

7.102 The following operator instructions apply for protection of the general public against excessive microwave exposure when operating appliances with **insertion applicator** or **large area contacting applicator**:

– The operator shall have access to an instrument according to 32.1.

– Inspect the walls, floors or ceilings that are to be treated for the presence of metal objects such as long nails, electrical cables, water pipes and air ducts. These ~~may~~ can firstly create local overheating and secondly act as antennas and transport microwave energy along. The microwave power setting ~~may~~ need to be reduced and particular attention is to be paid to possible microwave leakage outside what is typically considered the **restricted area**.

– Ensure that only the operator can be present in the **restricted area**.

– The boundaries of the **restricted area** are determined by measuring the power flux density with an instrument as specified in 32.1. An initial measurement series is made with the appliance located in the most onerous position with respect to expected boundaries of the **restricted area**. The instrument time constant of 2 s to 3 s is then used. The locations where the largest readings have been made are then to be re-examined, using a longer averaging time up to 6 min.

– Any measurement results shall be recorded in a journal for each job in the same building. In addition to the journal, a plot of the location(s) of the appliance shall be included as well as the point of measurements. For this purpose a copy of the plan drawing may be used.

– Since the boundaries of the **restricted area** ~~may~~ can change during **normal operation**, the boundaries shall be re-determined by several measurements of power flux density with an instrument as specified in 32.1.

– In case of doubt or missing relevant information about the construction of the building, the **restricted area** shall be enlarged.

NOTE Examples for how to make the **restricted area** inaccessible are: locking of doors of rooms lying in the **restricted area** or setting up a barrier installation. The mechanical stability requirements on barrier installations are under consideration. However, it is not possible to insert test probe B of IEC 61032 through the barrier installation.

– The **restricted area** shall be made inaccessible and be clearly marked with symbol ISO 7010-P004 (2011-05) and symbol IEC 60417-6166 (2012-07).

Compliance is checked by inspection.

8 Protection against access to live parts

This clause of Part 1 is applicable except for the application of test probe 18 of IEC 61032.

9 Starting of motor-operated appliances

This clause of Part 1 is applicable except as follows.

9.1 *Addition:*

Motors of the **traction drive** shall start under all voltage conditions that ~~may~~ can occur in use.

*Compliance is checked by starting the motor three times at a voltage equal to 0,85 times **rated voltage**, the motor being at room temperature at the beginning of the test.*

*The motor is started each time under the conditions occurring at the beginning of **normal operation** or, for automatic appliances, at the beginning of the normal cycle of operation. The motor shall be allowed to stop between successive starts. For appliances provided with motors having other than centrifugal starting switches, the test is repeated at a voltage equal to 1,06 times **rated voltage**.*

In all cases, the motor shall start and it shall function in such a way that safety is not affected and overload protection devices of the motor shall not operate.

10 Power input and current

This clause of Part 1 is applicable.

11 Heating

This clause of Part 1 is applicable except as follows.

11.7 *Modification:*

*Appliances with a **contacting applicator** for drying of floor, wall or ceiling structures, and appliances with an **insertion applicator** for moisture removal by insertion into holes in floor, wall or ceiling structures are operated as specified in 3.1.9 until steady conditions are established.*

12 ~~Void~~ 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~~.

~~**13.2** *Modification:*~~

~~The last sentence of the fourth paragraph beginning with "*For appliances intended to be connected in star connection only, ...*" is deleted.~~

~~NOTE 101 An electronic power converter with a supply of more than one phase can be damaged in most cases.~~

14 Transient overvoltages

This clause of Part 1 is applicable.

15 Moisture resistance

This clause of Part 1 is applicable.

16 Leakage current and electric strength

This clause of Part 1 is applicable except as follows.

16.101 The windings of the power transformer that supplies the magnetron shall have adequate insulation.

Compliance is checked by ~~the test of 16.101.1 for switch mode power supplies and by the test of 16.101.2 for other power transformers~~ one of the following tests.

~~**16.101.1**~~

– *For switch-mode power suppliers, the insulation between the primary and secondary windings of switch-mode power supply transformers is subjected for 1 min to a voltage of substantially sinusoidal waveform and having a frequency of 50 Hz or 60 Hz. The value of the voltage is 1,414 times the peak value of the secondary **working voltage** plus 750 V, with a minimum of 1 250 V.*

There shall be no breakdown between windings or between adjacent turns of the same winding.

~~**16.101.2**~~

– *For other power transformer, twice the **working voltage** is induced in the secondary winding of the transformer by applying a sinusoidal voltage having a frequency higher than **rated frequency** to the primary terminals.*

The duration of the test is

- *60 s, for frequencies up to twice the **rated frequency**, or*
- $120 \times \frac{\textbf{rated frequency}}{\text{test frequency}}$ *s, with a minimum of 15 s, for higher frequencies.*

NOTE The frequency of the test voltage is higher than the **rated frequency** to avoid excessive excitation current.

A maximum of one-third of the test voltage is applied and is then rapidly increased without creating transients. At the end of the test, the voltage is decreased in a similar manner to approximately one-third of its full value before switching off.

There shall be no breakdown between windings or between adjacent turns of the same winding.

17 Overload protection of transformers and associated circuits

This clause of Part 1 is applicable except as follows.

Addition:

The tests are not carried out on the power transformer that supplies the magnetron and its associated circuits; these are checked during the tests of Clause 19.

18 Endurance

This clause of Part 1 is replaced by the following.

Microwave barriers, **microwave guards** and other associated parts shall be constructed to withstand wear that ~~may~~ can be expected in normal use.

Compliance is checked by the following test.

***Microwave barriers**, **microwave guards** and other associated parts that are manipulated or accessed by an **instructed person** multiple times on a daily basis for inspection, **load** correction or similar shall be subjected to 10 000 cycles of operation.*

***Microwave barriers**, **microwave guards** and other associated parts that are regularly manipulated or accessed for servicing purposes on a daily basis or less shall be subjected to 300 cycles of operation.*

If there are more than one identical such barrier, guard or similar, only one is tested.

The number of operations is 6 cycles per 1 min or the maximum quantity that is given for the construction.

*After the test, the microwave leakage shall not exceed the limit specified in 32.1 and **microwave barriers**, **microwave guards** and other associated parts shall still function.*

NOTE 101 **User controls** can be rendered inoperative in order to carry out the test.

NOTE 102 Components, the deterioration of which does not impair compliance with this standard, can be replaced in order to complete the test.

19 Abnormal operation

This clause of Part 1 is applicable except as follows.

19.11.2 *Addition:*

*The cathode to anode circuit of a magnetron is open-circuited and short-circuited ~~in turn~~ one at a time. If one of these fault conditions results in an input current that increases with decreasing voltage, the test is carried out with the appliance supplied at 0,94 times **rated voltage**. However, if the input current increases more than proportionally with voltage, the appliance is supplied at 1,06 times **rated voltage**.*

The filament of a magnetron is not short-circuited.

19.101 *The **traction drive** of appliances with **contacting applicator** is defeated and the appliance is then operated on a horizontal metal surface exceeding that of the horizontal dimensions of the appliance by at least 70 mm on all sides, instead of the normal **load**.*

The period of operation is the maximum time allowed by the timer or until steady conditions are established, whichever is shorter.

The test in 32.101 is then made, without rod.

19.102 *Appliances with **large area contacting applicator** or **small area contacting applicator** are operated with **user controls** set at the most unfavourable position and placed on a horizontal metal surface exceeding that of the horizontal dimensions of the appliance by at least 70 mm on all sides, instead of the normal **load**.*

*Appliances with **small area contacting applicator** are in addition operated with **user controls** set at the most unfavourable position and held in free space, instead of at the normal **load**.*

*Appliances with **insertion applicator** are operated with **user controls** set at the most unfavourable position and placed in a metal tube with a metal bottom and a metal ring at the side of insertion with a diameter and length exceeding the dimensions of the part of the appliance intended to be inserted, instead of the normal **load**.*

The period of operation of appliances is the maximum time allowed by the timer or until steady conditions are established, whichever is shorter.

The test in 32.101 is then made, without rod.

19.103 *Appliances are operated under **normal operation** with the timer or other **user controls** that operate in normal use short-circuited.*

~~NOTE~~ *If the appliance is provided with more than one **user control**, these are short-circuited in turn. These short-circuits are applied one at a time.*

19.104 *Appliances are operated under **normal operation** and with any single-fault condition simulated that is likely to occur. The **controls** are adjusted to their most unfavourable setting and appliances with **contacting applicator** and **insertion applicator** are operated for the maximum time allowed by the timer or stationary conditions or 90 min, whichever is shorter.*

NOTE Examples of fault conditions are

– blocking of air openings in the same plane;
– locking the rotor of motors if the locked rotor torque is smaller than the full **load** torque;
– locking moving parts liable to be jammed.

19.105 *The position switches of the reversal **control** of the **traction drive** of appliances with **large area contacting applicator** are defeated and the appliance is then operated as in 3.1.9.*

The period of operation is the maximum time allowed by the timer or until steady conditions are established, whichever is shorter.

20 Stability and mechanical hazards

This clause of Part 1 is applicable except as follows.

20.1 *Addition:*

***Maintenance doors** which can be opened, lids and accessories shall be placed in the most unfavourable position.*

20.2 *Addition after the first paragraph:*

This is also to be applied on operating elements i.e. handles or hand wheels.

Modification:

The test probe 18 of IEC 61032 is not applicable.

20.101 Protective enclosures according to 20.2 shall not be **detachable** except where

– an appropriate interlock prevents operation of motors or fans without protective enclosures;
– it is a solid part of the housing of the appliance.

Compliance is checked by inspection.

21 Mechanical strength

This clause of Part 1 is applicable except as follows.

21.101 *Appliances with **large area contacting applicator** for a horizontal **load**, and with **insertion applicator** intended for vertical insertion are placed on a rigid floor, as in normal use.*

*A force of 140 N or the maximum force that can be applied without tilting the appliance, whichever is smaller, is then applied in a direction perpendicular to the **load** surface, to the free edges of **microwave barriers** and non-movable **microwave guards**.*

This test is carried out 10 times. There shall be no mechanical deformation.

*Appliances with **large area contacting applicator** for a vertical **load**, and with **insertion applicator** intended for horizontal insertion are placed against a rigid wall, as in normal use. A force corresponding to 4 times the mass of the appliance is then applied vertically to the outer part of the appliance and then vertically to the free edges of **microwave barriers** and non-movable **microwave guards**, for 1 min.*

The appliance shall not fall down. It shall also comply with 32.1.

*Handheld **small area contacting applicators** are placed against a rigid object, as in normal use. A force of 140 N is then applied axially, for 1 min.*

There shall be no mechanical deformation.

21.102 *The outside surface of **microwave barriers** and **microwave guards** and visually transparent protective devices over or inside **viewing openings** of appliances with **large area contacting applicator** and with **insertion applicator** are subjected to three impacts, each having an energy of 3 J. These impacts are applied to the central parts of the barriers and may be at the same point.*

The impact is applied by means of a steel ball having a diameter of 50 mm and a mass of approximately 0,5 kg. The ball is suspended by a suitable cord that is held in the plane of the barrier. The ball is allowed to fall as a pendulum through the distance required to strike the surface with the specified impact energy.

*Openable **microwave guards** are then opened and their inner surfaces are subjected to three similar impacts.*

NOTE The test is not made at accessible locations with removed **microwave barriers**.

*Any chokes and microwave absorbers on **microwave guards** are further tested by being subjected to three similar impacts. The impacts are made at three different locations.*

*Appliances with **small area contacting applicator** are held as in normal use. The outside surface of **microwave guards** of appliances with **small area contacting applicator** is subjected to a force of corresponding to 5 times the mass of the appliance or 20 N, whichever is smaller.*

The appliance shall then comply with 32.1.

21.103 *The power supply of the **small area contacting applicator** is placed in any position up to 1 m above the floor allowing the **small area contacting applicator** to fall down on a hardwood base having a thickness of 50 mm and being located where the **applicator** will hit it when dropped from a height of 1 m above the floor, with the cord to the power supply intact.*

*The **applicator** is then dropped onto the hardwood base.*

*This test is carried out five times, attempting to position the **applicator** so that its major axis is horizontal and so that a different part of it is exposed to the impact each time.*

*The **applicator** is then dropped five times attempting to position with its major axis vertically, with its active end pointing downwards.*

*The **applicator** shall not be damaged to such an extent that compliance with this standard is impaired, and in particular with regard to Clause 8 and 32.1.*

21.104 *The outside surface of **large area contacting applicators** and accessible **insertion applicators** positioned as in normal use are subjected to three impacts, each having an energy of 3 J. These impacts are applied to the most onerous parts and may be at the same point.*

The impact is applied by means of a steel ball having a diameter of 50 mm and a mass of approximately 0,5 kg. The ball is suspended by a suitable cord. The ball is allowed to fall as a pendulum through the distance required to strike the surface with the specified impact energy.

The appliance shall then comply with 32.1.

22 Construction

This clause of Part 1 is applicable except as follows.

22.40 *Addition:*

The switch shall have provisions for locking, such as a key or a key switch.

22.101 **Insertion applicators** and **large area contacting applicators** shall have an **available microwave power** of 2 000 W or less.

Small area contacting applicators shall have an effective microwave power of 200 W or less.

Compliance is checked by inspection and relevant measurements.

*The effective microwave power is calculated or measured at the feedthrough for coaxial line and **control** wiring (see key 9 in Figure 107) as follows:*

- *if there is a coaxial line between the microwave power generator and the **small area contacting applicator**, the losses in this coaxial line are to be measured or calculated under the condition of 25 % reflected power by means of conventional microwave methods;*
- *if there is a microwave isolator or a protective two-port attenuator between the microwave power generator and the **small area contacting applicator**, the manufacturer is allowed to use such data to increase the **available microwave power** under conditions of **normal operation**.*

22.102 **Large area contacting applicators** for drying of floor, wall or ceiling structures shall not have a smaller **applicator** opening than 1 cm^2 per W of **available microwave power**.

NOTE A minimum square opening is thus 35 × 35 cm for 1 200 W **available microwave power**.

Compliance is checked by inspection.

22.103 **Small area contacting applicators** shall not have a smaller **applicator** opening than 0,05 cm^2 per W of effective microwave power.

NOTE A minimum rectangular opening is thus 8 cm × 1 cm for 160 W effective microwave power.

Compliance is checked by inspection.

22.104 **Contacting applicators** for drying of floor, wall or ceiling structures equipped with automatic movement means of operation shall be provided with **controls** so that microwave generation is stopped when the appliance movement stops.

Compliance is checked by inspection of the appliance and its circuit diagram, and by relevant measurements and tests.

22.105 Appliances with **large area contacting applicator** and **insertion applicator** shall be provided with a means such that damage to the **supply cord** due to movement of the appliance, and appliance movement over **the supply cord**, are prevented as far as possible. The means provided shall be re-usable.

This requirement is considered to be met by, for example,

– a cord-retaining device to keep the **supply cord** out of the vicinity of the **microwave enclosure**, with the **supply cord** being ~~adequately~~ fastened to the appliance;
– the **supply cord** entry or attachment being at least 0,6 m from the nearest point of the **microwave enclosure**;
– mechanical guards being designed into the **microwave barrier**;
– expandable springs to which the cord is fastened or automatic cord reels or equivalent which are fixed above the floor.

Compliance is checked by inspection and by the following test procedure, except for automatic cord reel-in devices.

*The **supply cord** as delivered with the appliance is attached to the device in accordance with the instruction manual. The **supply cord** is then subjected 10 times to a pull of 100 N, the pull being applied in the most unfavourable direction, without jerks, for 1 s.*

*After the test, the power **supply cord** shall show no damage within the meaning of this standard and it shall not have been displaced longitudinally, in the device, by more than 2 mm.*

Appliances with **small area contacting applicator** shall be provided with a means such that damage to the grounded flexible cable containing a coaxial line and **control** wiring due to moving and turning the appliance is prevented as far as possible.

This requirement is considered to be met by, for example,

– a cord-retaining device to keep the grounded flexible cable containing coaxial line and **control** wiring out of the vicinity of the guard, with the grounded flexible cable containing coaxial line and **control** wiring being ~~adequately~~ fastened to the appliance, or
– the grounded flexible cable containing coaxial line and **control** wiring entry or attachment being at least 0,2 m from the nearest point of the guard.

Compliance is checked by inspection.

22.106 **Maintenance doors** and lids with hinges shall be constructed so that they cannot fall down unintentionally.

Compliance is checked by inspection.

22.107 Appliances with **large area contacting applicator** and with **insertion applicator** shall incorporate at least two **microwave interlocks** that are operated when the **applicator** is moved away from the **load**. Each of these interlocks shall operate before undue microwave leakage occurs and at least one of the interlocks shall operate by mechanical means.

Compliance is checked by inspection and the following test:

*All **microwave interlocks** except one are rendered inoperative. The appliance is supplied at **rated voltage** and operated with the **load** specified in 101.1.1 or 101.1.3. The microwave leakage is measured during the movement of the appliance.*

*The appliance shall comply with 32.101. The test is repeated on each **microwave interlock** in turn. Two test types are made: a first with a very slow movement away from the **load**, and a second test type with a very rapid movement away from the **load**. In the second case, the microwave generator shall be switched off within 3 s.*

NOTE 1 A **microwave interlock** can function by a microwave energy sensing device.

NOTE 2 **Microwave interlocks** are only tested if they are necessary for compliance with 22.107.

22.108 At least one **microwave interlock** shall incorporate a switch or an equally reliable method which disconnects the microwave generator or its supply main circuit.

Compliance is checked by inspection.

22.109 At least one of the **microwave interlocks** shall be concealed and not operable by manipulation. This **microwave interlock** shall operate before any accessible **microwave interlock** can be defeated.

Compliance is checked by the following test.

*The appliance is moved or not and an attempt is made to operate the concealed **microwave interlock** by applying test probe B of IEC 61032 to all openings. A straight rod, as shown in Figure 101, is also applied to any openings of the **microwave interlock** mechanism.*

*The appliance is moved and simultaneously an attempt is made to defeat any accessible **microwave interlock** by means of test probe B of IEC 61032.*

*It shall not be possible to operate the concealed **microwave interlock** during the tests.*

22.110 The failure of any single electrical or mechanical component that affects the operation of a **microwave interlock** shall not cause any other **microwave interlock** to become inoperative.

Compliance is checked by inspection and, if necessary, by simulating component failure and operating the appliance as in normal use.

22.111 A single fault such as failure of **basic insulation** or a loose wire bridging the insulation system shall not allow operation of the microwave generator when the **applicator** is moved away from the **load**.

*Compliance is checked by inspection and, if necessary, by simulating relevant faults. Wires that ~~may~~ can become loose are disconnected and allowed to fall out of position but are not otherwise manipulated. They shall not come into contact with other **live parts** or earthed parts if this results in all **microwave interlocks** becoming inoperative.*

NOTE 1 Failure of **reinforced insulation** or **double insulation** is considered to be two faults.

NOTE 2 Wires secured by two independent fixings are not considered likely to become loose.

22.112 **Microwave interlocks** operated by **detachable parts** shall be guarded so that accidental operation is prevented.

Compliance is checked by inspection and by manual test.

22.113 Lights, switches or push-buttons for the indication of danger, alarm or similar situations shall ~~only~~ be coloured red.

Compliance is checked by inspection.

22.114 In order to protect the **instructed person** during determination of the **restricted area** specified in 7.102, appliances with **large area contacting applicator** and **insertion applicator** shall be provided with a key switch or similar to operate it from a distance at which the power flux density is in conformity with 32.1.

NOTE This requirement ensures that the **instructed person** only gets closer to the operating appliance with **large area contacting applicator** and **insertion applicator** as long as the power flux density is in conformity with 32.1.

Compliance is checked by inspection.

22.115 **Insertion applicators** and **contacting applicators** without **traction drive** shall be provided with a timer limiting the time of operation to a value determined by **the instructed person**.

Compliance is checked by inspection.

22.116 The handheld unit of appliances with **small area contacting applicators** shall be provided with a **start switch** and an **operation switch**.

Compliance is checked by inspection.

22.117 **Small area contacting applicators** shall incorporate a stand.

Compliance is checked by inspection.

23 Internal wiring

This clause of Part 1 is applicable.

24 Components

This clause of Part 1 is applicable except as follows.

24.1

NOTE 101 IEC 60989 is not applicable to power transformers that supply the magnetron.

24.1.4 *Addition:*

Interlocks are subjected to the following test which is carried out on six samples.

*The interlocks are connected to a **load** that simulates the conditions occurring in the appliance when it is supplied at **rated voltage**. They are operated at a rate of approximately six cycles per minute. The number of cycles is*

– ***microwave interlocks on microwave guards*** *50 000;*
– *other interlocks:* *5 000.*

After the test, the interlocks shall not be damaged to such an extent that their further use is impaired.

25 Supply connection and external flexible cords

This clause of Part 1 is applicable except as follows.

25.1 *Modification:*

Appliances shall not be provided with an appliance inlet.

25.5 *Modification:*

Type X attachments shall not be used.

25.7 *Replacement:*

Supply cords shall not be lighter than

– if rubber insulated, ordinary tough rubber sheathed flexible cord (code designation 60245 IEC 53);
– if polyvinyl chloride insulated, ordinary polyvinyl chloride sheathed flexible cord (code designation 60227 IEC 53).

In some countries, these **supply cords** are not suitable and the **supply cord** shall be ordinary polychloroprene sheathed flexible cord (code designation 60245 IEC 57).

Compliance is checked by inspection.

NOTE 101 A requirement to use **supply cords** with an outer metal-braided sheath is under consideration.

25.14 *Addition:*

This requirement also applies to external cables or cords where, because of the design of the appliance, there is relative movement of more than 45° of the cable or cord at its point of entry into an enclosure.

25.15 *Addition:*

This requirement applies to all accessible cables or cords.

Replacement of the fourth paragraph:

A mark shall be made on the cord on the appliance side of the cord anchorage while it is subject to the pull force shown in Table 12, at a distance of approximately 2 cm from the cord anchorage or other suitable point. If access to the appliance side of the cord anchorage is not practicable then the mark shall be made on the supply side of the anchorage and it shall be ensured that the pull force is applied to the cord in such a way that, at the point of application of the force, the sheath of the cord does not move with respect to the conductors or their insulation.

Modification:

*The pull force on the **supply cord** shall be 150 N.*

26 Terminals for external conductors

This clause of Part 1 is applicable.

27 Provision for earthing

This clause of Part 1 is applicable except as follows.

27.101 Any external interconnection cable(s) between a separate main power supply (supplies) in a separate enclosure and the **applicator** portion in a separate enclosure shall include an additional earthing wire for high voltage circuits. The insulation of the wire shall correspond to the requirements for insulation for operating high voltage.

27.102 Any secondary (high voltage) circuit earthing of magnetrons by a separate wire shall be connected to its waveguide in such a way that the wire does not come loose during service or repair.

28 Screws and connections

This clause of Part 1 is applicable except as follows.

28.1 *Addition:*

Screws made of carbon steel and alloy steel shall be made in accordance with ISO 898-1.

Screws made of corrosion-resistant stainless-steel shall be made in accordance with ISO 3506-1 or ISO 3506-2 or ISO 3506-3 or ISO 3506-4.

28.4 *Addition:*

Screws that make mechanical connections and electrical connections shall be so designed that the contact pressure does not change appreciably through loosening of the screwed assembly parts during operational stress and contact corrosion.

Screws that make mechanical connections and provide earthing continuity shall

– be one of types specified in Table 101 and be made in accordance with ISO 898-1 or ISO 3506-1 or ISO 3506-2 or ISO 3506-3 or ISO 3506-4, and
– have a minimum outer thread diameter of 2,8 mm, and
– be so designed that the contact pressure does not change appreciably through loosening of the screwed assembly parts due to operational stress and contact corrosion. They shall be designed so that a minimum contact pressure remains.

Compliance is checked by inspection and by measuring the assembling torques for screwed connections providing earthing continuity by applying a torque as specified in Table 101 to turn the screw in the fastening direction. The screw shall not turn.

The screw shall not have been unfastened prior to performing this test.

Table 101 – Assembling torques for screwed connections providing earthing continuity

Outer thread diameter of the screw mm	Assembling torque Nm	
	Screwed connections for the mechanical strength of the screws A2-70 according to ISO 3506-1, or ISO 3506-2, or ISO 3506-3, or ISO 3506-4 and 5.8 according to ISO 898-1	Screwed connections for the mechanical strength of the screws > 8.8 according to ISO 898-1
> 2,8 and ≤ 3,6	0,8	1,3
> 3,6 and ≤ 4,2	1,9	3,0
> 4,2 and ≤ 5,3	3,7	6,0
> 5,3 and ≤ 6,3	6,5	10,0
M8	15,0	25,0
M10	31,0	50,0

29 Clearances, creepage distances and solid insulation

This clause of Part 1 is applicable.

30 Resistance to heat and fire

This clause of Part 1 is applicable except as follows.

30.2 *Addition:*

30.2.3 is applicable.

31 Resistance to rusting

This clause of Part 1 is applicable.

32 Radiation, toxicity and similar hazards

This clause of Part 1 is applicable except as follows.

32.1 *Addition:*

Appliances shall be so constructed and enclosed that there is adequate protection against access to the **microwave enclosure**, and that any microwave energy emanating from it is non-hazardous.

Microwave leakage is determined by measuring the microwave flux density using an instrument capable to measure microwave flux densities from about 5 W/m^2 to at least 250 W/m^2, that reaches 90 % of its steady reading in 2 s to 3 s when subjected to a stepped input signal. To simplify the use of the instrument, a non-interfering spacer is mounted on the sensor probe, providing a required minimum distance of 50 mm between the sensor and any external object.

*The microwave leakage reading with the sensor at any point 50 mm or more from the external surface of the appliance or any **microwave barrier** shall not exceed 50 W/m^2, averaged over the most onerous 20 s interval. The instrument reading shall not exceed 250 W/m^2.*

NOTE Microwave leakage can vary with power pulsing (including brief operation under the test conditions in 22.107, 19.101 and 101.1.1) and **load** variations. Depending on the actual time constant of the instrument, readings are then taken every 2 s or 3 s.

*Compliance for appliances with **large area contacting applicator** is checked by the test in 32.101 under the conditions in 101.1.1. Compliance for appliances with **insertion applicator** is checked by the tests in 32.101 under the conditions in 101.1.3. Compliance for appliances with **small area contacting applicator** is checked by the tests in 32.101 under the conditions in 101.1.2.*

32.101 *In a first test series, all **microwave barriers** are in place and the spacer tip is moved over and away from the external surface of the appliance and **microwave barrier** to locate the highest microwave leakage, particular attention being given to the openings and the microwave **barriers**. The region inside a geometric opening into the **microwave enclosure** or **microwave barrier** is not regarded as accessible.*

*A second test series is then carried out at the openings of appliances with **large area contacting applicators** and **insertion applicators** as specified in ~~Table 101~~ Table 102, with removed **microwave barriers**, and any interlock to any of them being defeated. A metal rod with 2,5 mm diameter and 100 mm length (test probe C of IEC 61032) is used with the instrument sensor spacer for this test, as shown in Figure 102. During the operation, the free rod end is moved in any position near but not inside the surface of the geometric openings specified in ~~Table 101~~ Table 102. The position of the sensor is not to be any closer than 50 mm to any part of the external surface of the appliance, and to the surface of the geometric opening of the **microwave enclosure**.*

Two additional sensor spacer tip and rod locations are to be used: as shown in Figure 102 but with the spacer tip and its rod end now placed at the opening; and with the rod centre mounted at the sensor spacer tip and a rod end at the opening.

*If the leakage reading is less than 50 W/m^2 the reference surface for 101.6 is at the surface of the geometric opening of the **microwave enclosure** without **microwave barrier**. If the leakage reading exceeds 50 W/m^2 under these conditions, the locations of the sensor (not spacer tip) further away from the **microwave enclosure** where this value is measured are recorded. The position of the reference surface away from the surface of the appliance is then determined as 50 mm straight inwards from this sensor position and towards the surface of the appliance.*

NOTE The optimum length of the wire is different for operating microwave frequencies other than 2 450 MHz.

32.102 *All **microwave guards** and **microwave barriers** are in place and the spacer tip is moved over and away from the external surface of the appliance and any **microwave guard** or **microwave barrier** to locate the highest microwave leakage, particular attention being given to the openings. The region inside a geometric opening into the **microwave enclosure** or **microwave guard** or **microwave barrier** is not regarded as accessible.*

32.103 *With all **microwave guards** of **small area contacting applicators** in place, two additional sensor spacer tip and rod locations are to be used: as shown in Figure 102 but with the spacer tip and its rod end now placed at the opening between the **microwave guard** and the **load**; and with the rod centre mounted at the sensor spacer tip and a rod end at the opening.*

101 Protection against accessibility to microwave-containing regions

101.1 The microwave leakage-preventing action of mating parts of **applicators** and the **load** shall provide adequate protection against microwave leakage.

NOTE Means of leakage prevention can be capacitive seals, quarterwave chokes (acting by impedance transformation), mode chokes (acting by field pattern mismatching) and microwave energy absorbers.

Compliance is checked by inspection and the applicable tests in 101.1.1 to 101.1.2.

101.1.1 Large area contacting applicators are operated under the conditions in 3.1.9 and additionally with a second **load** consisting of a compact assembly of softwood planks with a moisture content of 15 % to 20 %. The assembly should extend at least 120 mm outwards from the space of the **applicator** and be at least 200 mm high.

101.1.2 Small area contacting applicators are operated under the conditions in 3.1.9.

101.1.3 Appliances with **insertion applicator** for moisture removal by insertion into holes in floor, wall or ceiling structures are operated under the conditions in 3.1.9.

101.1.4 The dimensions of **viewing openings** and permanently open means of access for ventilation, liquid evacuation or similar shall be less than 20 mm × 50 mm.

Compliance is checked by inspection.

101.2 The free height between a **large area contacting applicator** and a flat **load** shall be less than 20 mm.

Compliance is checked by inspection of the appliance and its instruction sheet.

101.3 If the manufacturer's specifications allow use of the appliance with non-flat **loads**, the test in 22.107 is repeated with the most onerous **load** geometry allowed by that specification.

Compliance is checked by inspection of the appliance and its instruction sheet.

101.4 The free accessible distance between the external housing or any **microwave guard** of an appliance with **insertion applicator** and the **load** shall be less than 20 mm.

Compliance is checked by inspection.

101.5 The free accessible distance between the **microwave guard** of a **small area contacting applicator** and a flat **load** shall be less than 20 mm.

Compliance is checked by inspection.

101.6 There shall be **microwave barriers** if there are accessible openings into the **microwave enclosure**.

There shall be **microwave barriers** between a **large area contacting applicator** and the **load**, and at an **insertion applicator** and its **load**.

Microwave barriers shall not be constructed of metal or microwave-absorbing material in such a way that they can guide or absorb microwaves and their accessible openings shall not be larger than the openings that they protect.

Microwave barriers shall be removable only with the aid of a **tool**.

NOTE 1 The function of the **microwave barrier** is to act solely as a mechanical barrier.

Microwave barriers shall withstand the tests in 21.101 and 21.102. Furthermore, it shall not be possible to insert the test probe B of IEC 61032 through any holes in **microwave barriers**, with exception of the accessible end opening.

Compliance is checked by inspection, the specified tests and the tests in ~~Table 101~~ Table 102.

*The dimensional and microwave leakage measurement requirements on **microwave barriers** in relation to the dimension and type of opening are given in ~~Table 101~~ Table 102. The barrier length is calculated from the reference surface as obtained by the applicable measurements in 32.101 but shall extend all the way to the opening of the **microwave enclosure**.*

Table ~~101~~ 102 – Specifications for microwave barriers

Opening dimension	Allowed use	Required barrier extent	Microwave leakage measurement	Remarks
Up to 20 mm	Only between **contacting applicator** and the **load**	80 mm from reference surface	With and without 100 mm rod. 20 s time of integration	
20 mm × 50 mm to Ø 12 mm	Any purpose	80 mm from reference surface	With and without 100 mm rod. 20 s time of integration	
Ø 12 mm to Ø 3 mm	Any purpose	None	Only without rod. 20 s time of integration	Ø 12 mm holes in **applicator** walls will need protection against leakage
< Ø 3 mm and narrow slots in metal surfaces	Any purpose	None	Only without rod. The leakage measurement integration time is that of the instrument (2 s to 3 s) for narrow slots	

Compliance is checked by inspection and the applicable tests in 32.101 and 32.102.

NOTE 2 A method for testing the microwave properties of the **microwave barrier** is by a heating test of a part of it in a laboratory microwave oven, for about 30 s. Appropriate material will not become hot and in particular there will be no hot spots.

NOTE 3 At 2 450 MHz, narrow slots in an **applicator** can radiate significant microwave energy if their length approaches a half wavelength. A contacting part of the body can then be subjected to a very local but high power absorption even when there is a small leakage measured 50 mm away. There will be no leakage from slots less than 3 mm wide in TE_{10} waveguides, along a wide side longitudinal centreline or in the short side in the plane of a transverse cross section.

101.7 Microwave guards shall withstand the tests in 21.101 and 21.102. Furthermore, it shall not be possible to insert the test probe B of IEC 61032 through any holes in it, with exception of the opening according to 101.6 at the **load**.

*Compliance is checked by inspection and the specified tests. After these tests, the **microwave guards** shall comply with 32.102.*

Dimensions in millimetres

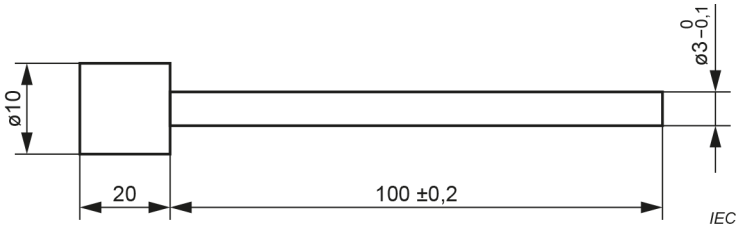
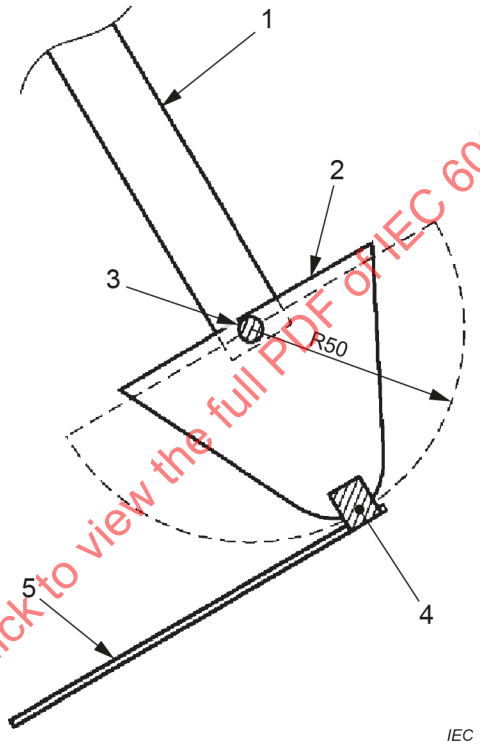


Figure 101 – Test rod for interlock concealment

Dimensions in millimetres



Key

1 probe handle

2 probe spacer

3 field sensor

4 tape

5 metal rod

NOTE 1 A hollow metal tube can be used instead of a solid rod. Its outer dimensions are $L = 100^{\pm 1}$ mm, $\varnothing = 2{,}5^{\pm 0{,}15}$ mm. As material, non-magnetic metal like aluminium or brass can be used.

NOTE 2 The rod can be fixed to the probe spacer with a thin **microwave transparent** tape so that the field sensor is located approximately 90° out from the end of the rod. Only when there is not enough space in the vicinity of the access opening the sensor can be more aligned with the rod. The minimum distance from the rod – and any other part of the appliance, including the surface of the access opening – to the field sensor is 50 mm.

NOTE 3 Since the rod acts as an antenna, contact between the rod and metal part can cause spurious readings. Thus, maintaining a minimum distance can be maintained.

Figure 102 – Arrangement for measurement of microwave leakage

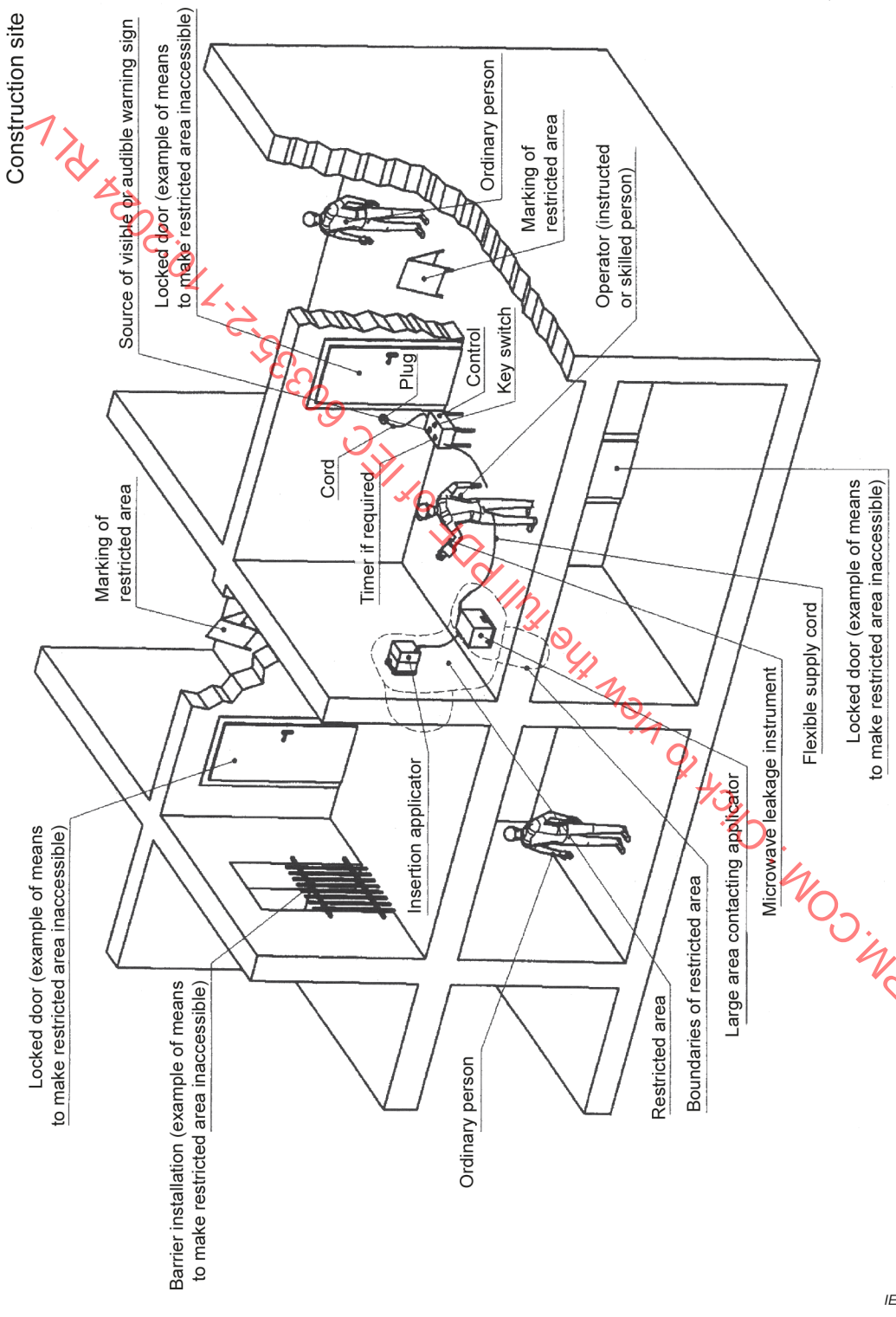


Figure 103 – Construction site, overview of different applicator types and their use

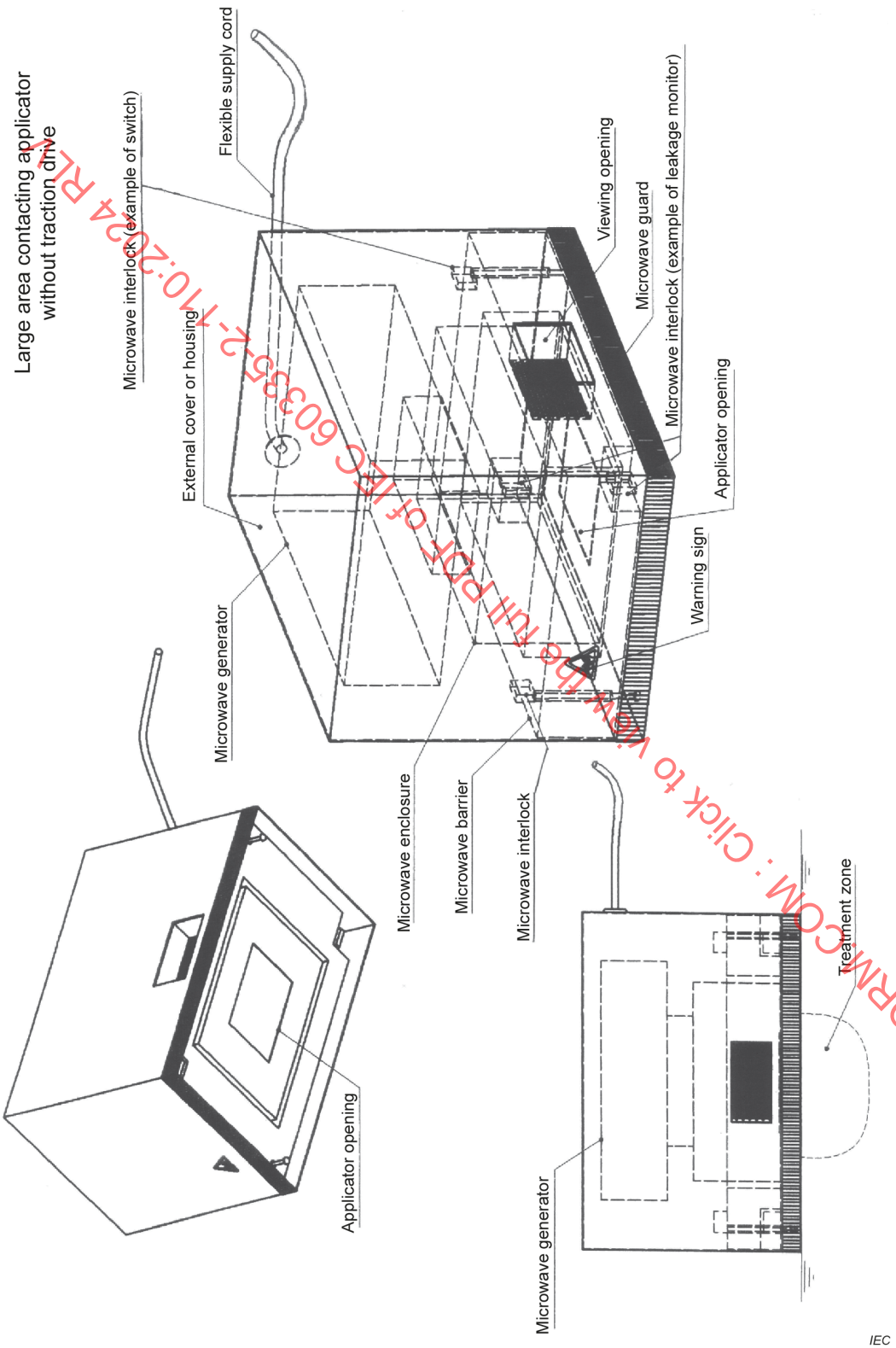


Figure 104 – Large area contacting applicator without traction drive

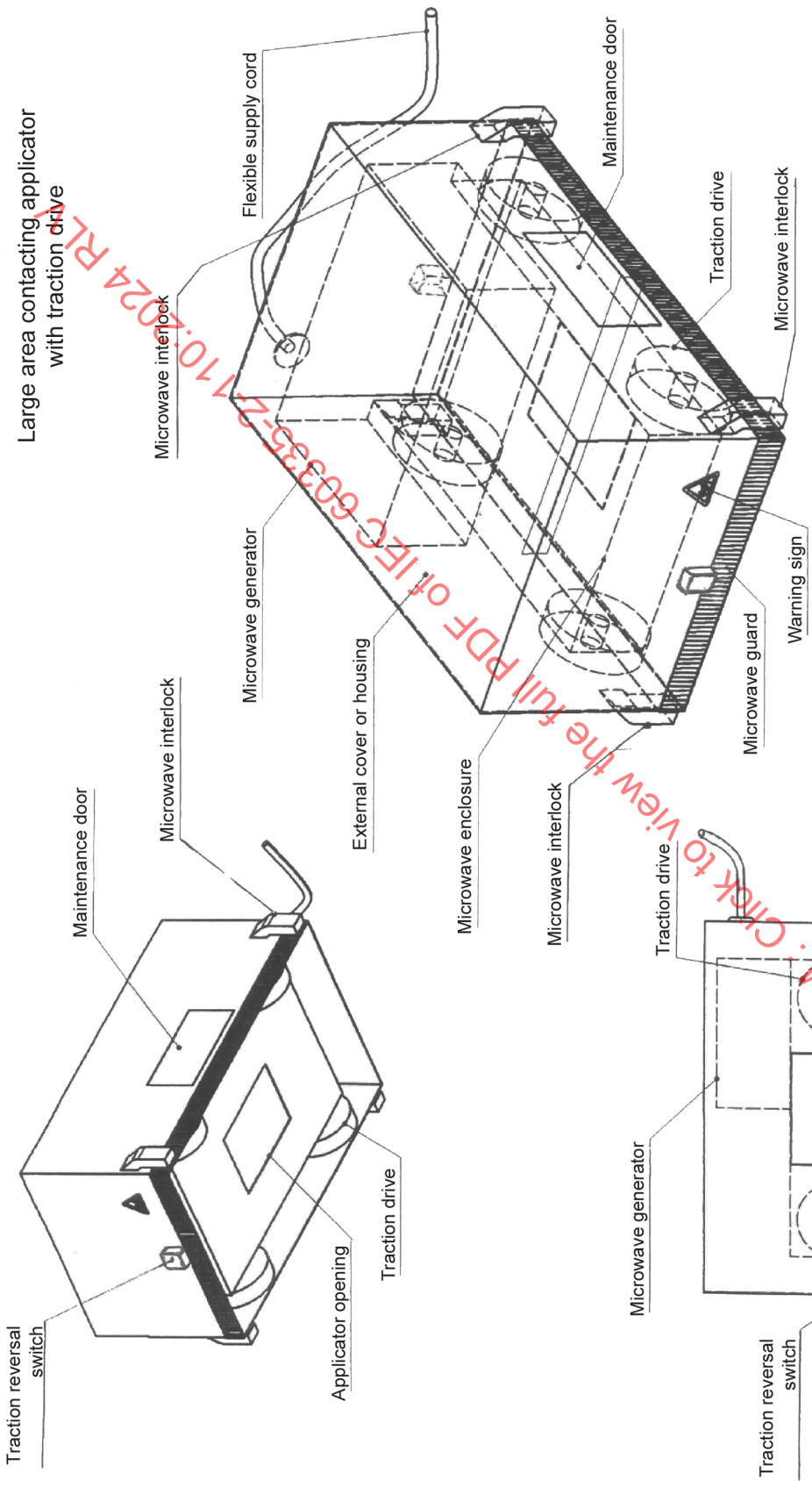


Figure 105 – Large area contacting applicator with traction drive

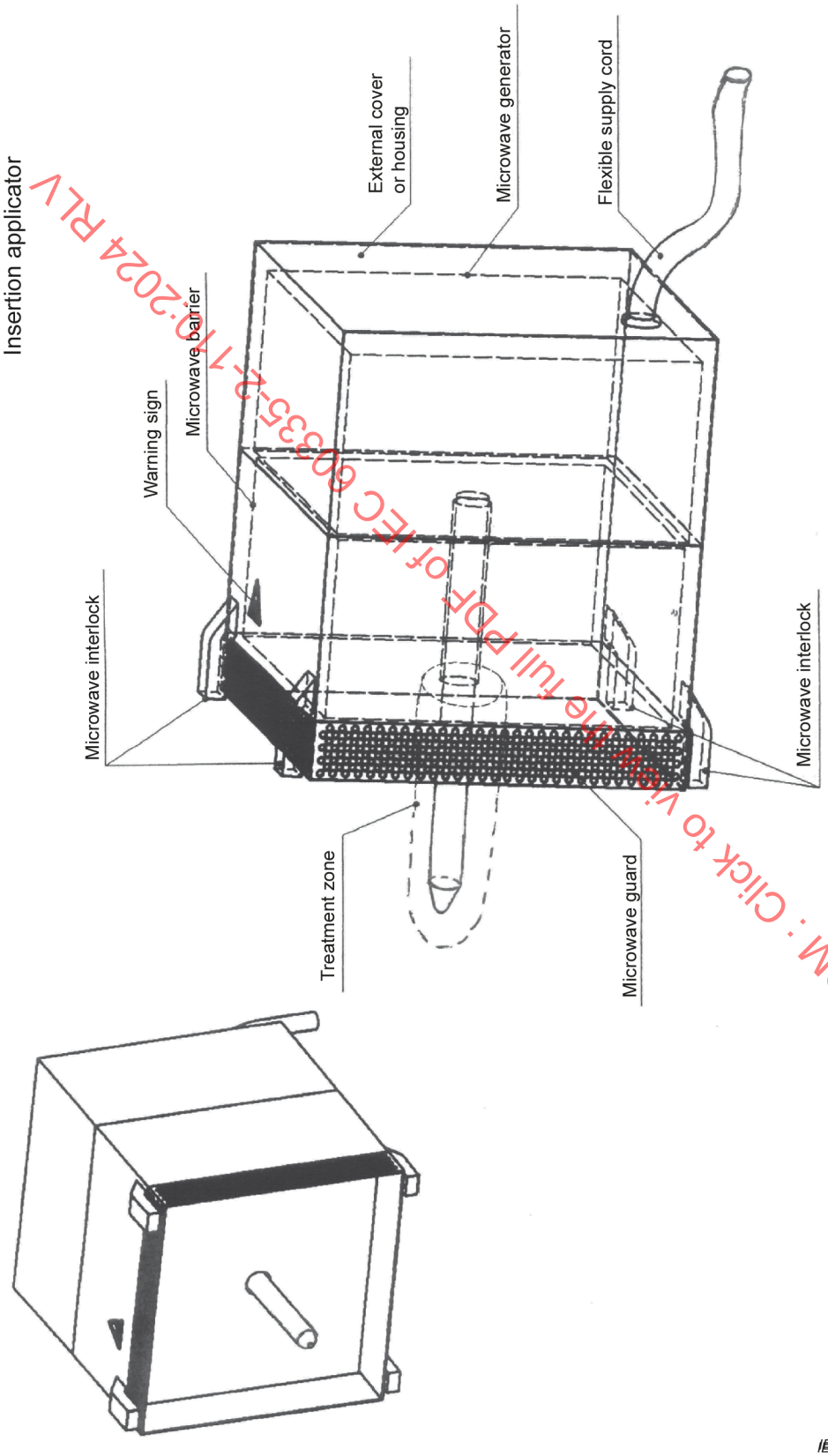
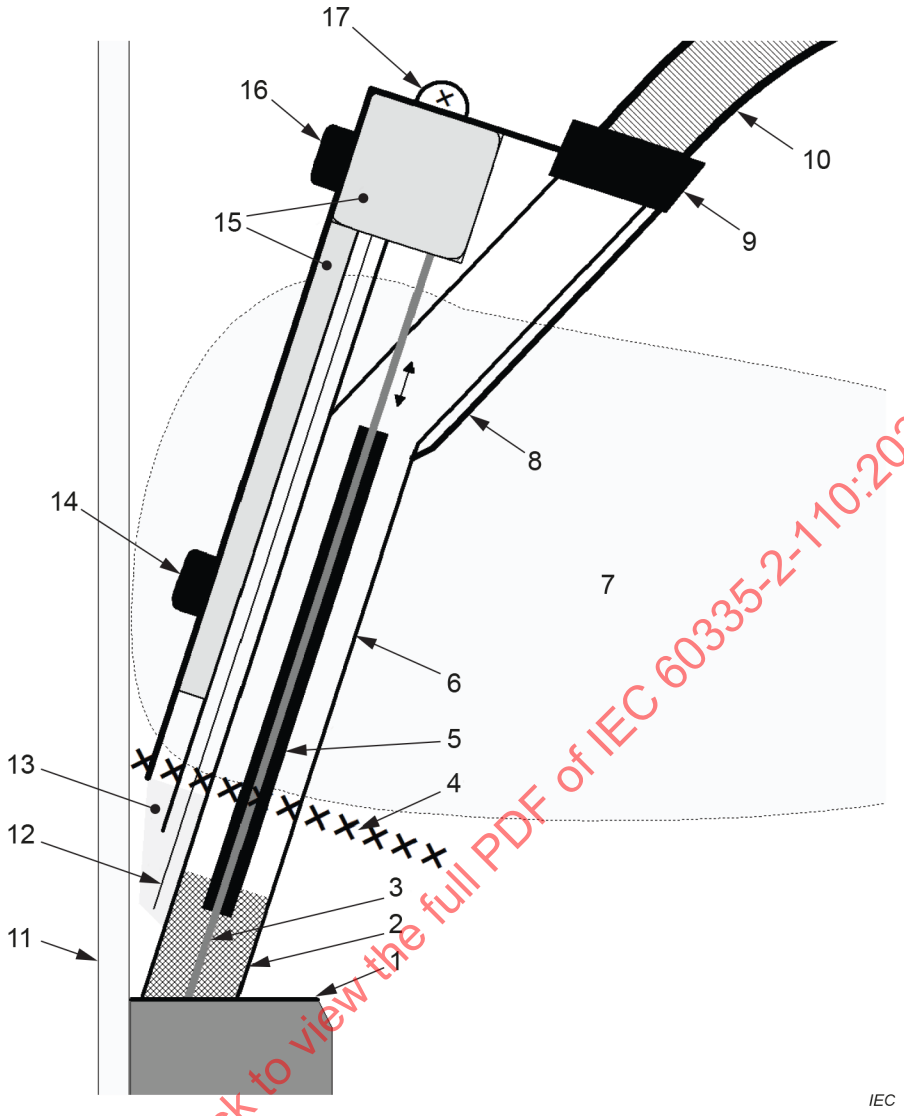


Figure 106 – Insertion applicator



Key

1 **load** (e.g. window frame with paint to be removed)
2 **small area contacting applicator** in metal housing (non-radiating into free space)
3 spring-loaded axial **microwave transparent** rod for **load** presence sensing, activating a **microwave interlock**
4 asymmetric guard or **microwave guard**
5 centre conductor of coaxial line (its continuation upwards to the right not shown)
6 metallic tube, also outer conductor of coaxial line
7 area of the gripping position of the operator's hand when appliance is in use
8 outer enclosure, also containing **control** wiring
9 feedthrough for coaxial line and **control** wiring
10 grounded flexible cable containing coaxial line and **control** wiring
11 glass window above the window frame
12 microwave leakage sensor
13 **microwave transparent** cover (made of e.g. plastic) for microwave leakage sensor
14 **operation switch**
15 space for electrical components and wiring
16 **start switch**
17 operation lamp (orange or yellow)

Figure 107 – Small area contacting applicator

Annexes

The annexes of Part 1 are applicable except as follows.

Annex AA
(informative)

Rationales for the microwave barrier and associated leakage tests

AA.1 Standard measurement of microwave oven leakage

There are several commercial instruments on the market. Those that perform sufficiently well for the purpose have a small, reasonably isotropic (omnidirectional) sensor at the end of a plastic rod. The sensor reacts to the electric field only. There is also a non-disturbing sensor spacer which is used to determine a 50 mm minimum distance between the sensor and any part of the appliance as specified in the standard. Testing of instruments include calibration in the far field (the inaccuracy is allowed to be about ± 20 %), and one or two tests intended to show that the sensor is "electrically small" so that it does not itself cause interference (standing waves) to objects nearby.

The scale on microwave leakage instruments is not in the same units as what is actually measured (V/m) but instead in W/m^2 (or mW/cm^2). The conversion is correct only in the free space plane wave case, where the wave impedance is 377 Ω and there is unidirectional propagation. Since a standing wave is the sum of two waves propagating in different directions, and the probe is not direction-sensitive, the field impedance then becomes smaller or larger than 377 Ω, so that the instrument reading becomes erroneous. Erroneous readings are also obtained in strongly curved near fields and with the probe in a waveguide or similar where there is a single or multiple mode (having a different impedance).

The minimum 50 mm distance between the instrument sensor and any accessible part of the appliance was specified more than 40 years ago when the first microwave oven leakage standard was created. The major reasons were that it was found desirable to use the same type of instruments which were used for far-field exposure measurements, and that it was concluded that an electric field sensor instrument would not indicate a proper value for determining the outgoing power flux density if the probe was located

a) where the field curvature was very significant (in comparison with the wavelength),

b) in the presence of any standing waves near the sensor.

A reasonable compromise with the need to measure emission (i.e. in the source region, so that the "leaking spot" could be found) was found to be 50 mm for the 2 450 MHz ISM band. Even if it was noted in the instrument literature at the time that the same 50 mm distance would be less appropriate for the lower ISM band at 915 MHz, the matter was not considered so problematic that the specification was modified.

The historical reason for the choice of the maximum allowed level of 50 W/m^2 (= 5 mW/cm^2) was a result of an existing regulation on free space power flux density of up to 100 W/m^2 being acceptable in commercial and industrial environments, plus considerations of a possibility of two or more microwave ovens being located close to each other. Later, when household microwave ovens came on the market, the nature of door leakage was found to typically be from only some few leaking spots, so that the power flux density decreased almost quadratic with the distance away from these. There was no reason why the user would remain very near the closed door of an operating oven, and widely publicised investigations showed that the actual exposure of any part of the human body became very low, particularly in consideration of a reasonable averaging time of 5 min to 10 min for hazard assessment. As a result, the 50 W/m^2 limit was applied also to household microwave ovens.

In the beginning of the 1970's, the US authorities responsible for radiation safety found some quality problems with some microwave oven models and introduced a 10 W/m^2 "factory limit" for new unused ovens, in order to dampen any public concerns. Only one or two other countries followed.

In the meantime, IEC 60335-2-25, the safety standard for microwave oven for household and similar use was successively developed and the value 50 W/m^2 became the worldwide limit after all tests. However, in empty operation and after a potentially destructive door test, 100 W/m^2 was instead required. The rationales for the higher value under no-load conditions were reported difficulties by some manufacturers, and the conclusion that no-load operation would typically be even more short-term and an also uncommon fault condition.

In the 1980's, leakage measurements at covers for lamp replacement were dealt with by the experts maintaining IEC 60335-2-25. The hole array in the cavity wall, at the lamp, can of course leak microwaves. The size of the cover ~~may~~ can be such that the 50 mm distance to the nearest appliance part can be maintained also with the sensor almost inside the external housing from which the cover has been removed. A case had been reported where the instrument reading was quite high in this condition, but there was a very low reading with the whole housing removed. The reason for the high reading was that a standing wave inside the housing had been created. There was an electric field but no real leakage since the standing wave is the sum of an outwards- and inwards-going wave and ~~may~~ can have no net power flux. In addition, if a finger would be put into the opening, the standing wave would disappear and only the real leakage becomes the possible hazard. As a consequence, a statement was added to the standard to the effect that the instrument sensor should not be closer to the opening plane than 50 mm, i.e. the region inside the cover should not be considered accessible with regard to the leakage measurement. The same principle is adhered to in this standard, but the actual leakage situation is now really assessed, by the extended test in 32.1.

AA.2 Microwave hazards – the basic restriction

Microwave exposure is considered to be potentially hazardous if the heating of parts of the human body exceeds certain values. These are specified as SAR values (specific absorption rate) and are expressed in W/kg tissue. The lowest SAR value of whole-body exposure where there ~~may~~ can be some risks has been found to be 4 W/kg. A safety factor of 10 is subsequently applied for **instructed persons** and a further safety factor of 5 for **ordinary persons**, resulting in the basic restriction of 0,4 and 0,08 W/kg in the two cases. Local, non-hazardous exposure limited to the head and trunk ~~may~~ can be up to 10 W/kg and 2 W/kg, respectively. Twice this (20 W/kg and 4 W/kg) are considered non-hazardous locally in the extremities (including hands and fingers). The general microwave standards specify integration over any 10 g body mass, and the time integration is over 6 min.

AA.3 Microwave hazard evaluation – the free space exposure method

For all practical exposure situations (except from communication devices such as mobile phones for which a total source maximum power concept ~~may~~ can apply), two simplified verification methods are used in industry and for protection of microwave workers and the general public: a maximum allowed far-field power flux density far away from the source, and an emission standard for appliances such as microwave ovens.

The issue is now if the relaxation of SAR values for parts of the body, in combination with the integration volume, are compatible with the free space exposure method.

When parts of the human body having a small radius of curvature are heated, diffraction, resonant and other focussing or amplification phenomena ~~may~~ can occur. In the case of 2 450 MHz, the internal wavelengths in tissues as well as the penetration depth limitation result in only fingers being of major interest. In principle, also bent knuckles and elbows could create focussing effects, but fingers are definitely much more problematic with regard to the effects discussed here. It is not assumed that other protruding parts of the body such as the nose, ears or penis are brought very close to microwave leakage sources in commercial or household heating equipment.

The following modelling results indicate the degree of compatibility between the basic restriction and the free space exposure method:

Numerical modelling using commercially available electromagnetic software was used. A finger with 13 mm diameter and typical dielectric data (homogeneous, with $\varepsilon^* = 40 - j10$, where the loss factor (10) is lowered in consideration of bone and tendons) was exposed to 10 W/m^2 in free space. The strongest absorption occurred for TM_Z polarisation (i.e. with the impinging electric field parallel to the finger axis) and the mode in the finger then becomes of the TM_{Z1} type, having two opposite axial zones of maximum heating intensity. The maximum power intensity becomes 5 W/dm^3 and the average over the worst 10 cm^3 becomes about 1,8 W/dm^3.

If the finger would be exposed to a plane wave with a power flux density of 50 W/m^2 – that which is allowed from microwave ovens, etc. – the maximum value would become 25 W/dm^3 and the 10 cm^3 integrated value would become 9 W/dm^3.

The conclusions are that:

- The **ordinary person** basic restriction is exceeded. However, the types of appliances dealt with in this standard are not operated by **ordinary persons**.
- The **instructed person** basic restriction is about the same as the actual SAR value. However, the actual situation with **large area contacting applicators** as well as with **insertion applicators** is that the operator is never close to the **applicator** opening or rod antenna. A negative factor is, however, that opening regions of these **applicators** are larger than spots of an oven door as a leakage source, so that the region with a high microwave energy density ~~may~~ can extend further out than from an oven door. Hence, the construction of the **applicators** and barriers as well as the measurement method ~~must~~ shall ensure that SAR values of 20 W/kg in the human extremities are not exceeded.

AA.4 Microwave hazards from open applicators

The actually absorbed microwave power in a part of the human body is always very dependent on the field configuration, and the field configuration at the body part is also strongly modified by the part itself. This means that even knowledge about the true power flux density or the electric field intensity cannot be used to assess the actual microwave absorption rate and it becomes necessary to establish a more complete scenario before any calculations of the absorption can be made. Hence, the leakage intensity measured as a quasi-plane free space wave at 50 mm or more away from the source will now not alone determine the level of hazard. The actual hazard also depends on:

- any possibility of access into a region where there is microwave energy,
- the size of the opening, which ~~may~~ can determine the type of field characteristics, or allow several kinds of microwave field characteristics,
- any objects, including a **load** to be heated or a part of the body at the opening, which ~~may~~ can also determine the type of field characteristics.

The access situation is of course crucial and shall be standardised in some ways so that reasonably simple and objective procedures and requirements can be established. Since only the arm, hand and finger (and leg, foot and toes) are considered to be the parts of the body which ~~may~~ can get in contact with or close to **applicator** openings of these appliances, two important issues can be directly quantified:

a) all geometric factors (by test probe B, etc.), and

b) as addressed above, these parts of the body are less sensitive than for example the head.

An important principle is that a "hazard boundary" (called reference surface in this standard) is defined somewhere in the vicinity of the physical opening surface and that a leakage instrument reading of 50 W/m^2 is to apply for the tests. This means that what remains is to construct tests which will ensure, with reasonable certainty, that actual power densities (in W/m^3, or SAR values in W/kg) in human extremities "contacting" the reference surface will not exceed those caused by a "normal" leakage source such as a microwave oven door region giving a power flux density reading of 50 W/m^2 at 50 mm distance from any part of the appliance.

The field configuration then becomes the issue, i.e. how to obtain realistic measurement results with the same type of instruments as are used for microwave ovens with a door. Clearly, there is a need for simplification and standardisation using some typical scenarios. The most important matter is then to consider cases where access would be more severe than in the normal door leakage case. These "onerous" cases are as follows.

- The field configuration is such that there is a very high intensity in a region, and the intensity diminishes very quickly with increasing distance, so that no reading ~~may~~ can be obtained with the sensor 50 mm away from the **applicator** opening – but there is obviously a quite hazardous microwave energy density at the opening. Structures creating non-radiating near fields or strongly evanescent modes have this effect. **Small area contacting applicators** are excellent examples of this – they do in fact need to have such characteristics for compliance with this standard and there ~~must~~ shall of course be adequate protection of the operator against access to the **applicator** opening.
- The field configuration is such that a microwave power flux is bound to a dielectric object. The **loads** being treated with **large area contacting applicators** are the most typical example, and a bound surface wave ~~may~~ can then exist, and "transport" microwave power away from the opening. The "best" condition for this phenomenon occurs with **loads** having a very high water content (a very high dielectric constant ε'). There ~~may~~ can then be no leakage instrument reading with the sensor 50 mm up, but with the metal rod in Figure 102.

In this standard, a method of leakage extraction and non-shielding **microwave barriers** is used. One end of the metal rod ~~may~~ can act as a receiving antenna and since the end can be located very close to parts of the **applicator** and **load**, it will also pick up near fields, evanescent modes and surface waves when suitably oriented. A "spatial averaging" of the externally available microwave energy also results, since the instrument sensor is still not closer than 50 mm to any other object.

AA.5 Time averaging

There are only two time integration specifications in the existing national standards by radiation protection agencies:

a) 6 min for whole-body exposure (probably including fingers), and

b) criteria for duty cycles in cases of very short pulses such as from radar transmitters. Additionally, in some national legislation on non-ionising radiation, there is a ceiling value of exposure; a ceiling value of e.g. 250 W/m^2 and a 10 W/m^2 average ~~may~~ can be interpreted as maximum 300/25 = 12 s, isolated strong exposure being allowed during any 6 min interval, with no exposure during the remaining 5 min 48 s of the interval.

The 6 min integration time is quite compatible with typical cases of irradiation of parts of the body having a radius of curvature larger than about one free space wavelength of 2 450 MHz microwaves. In such cases, essentially a plane damped wave propagation can be assumed, as well as a depth of 30 mm to 40 mm in the tissue over which equilibration by heat conduction takes place. Using the heat conductivity data and the Fourier heat conduction equation then results in a time constant (i.e. about 63 % of the stationary conditions have occurred) of about 5 min. A useful comparison is with boiling of an egg in 100 °C water: it takes about 5 min for the centre to reach a temperature of about 65 °C.

The most onerous heating pattern in a diameter 13 mm finger under plane wave 2 450 MHz irradiation is uneven, with about 5 mm distance between the hot and cold areas. It can be shown that the overall microwave coupling is strongest for about a diameter 16 mm finger. The corresponding distance between hot and cold areas then becomes 7 mm or less.

The Fourier heat conduction equation is spatially quadratic. Using the boiling of a diameter 40 mm egg in 5 min having distance between the cold and hot regions is 20 mm as a basis, a 7 mm distance would be similarly equilibrated in $(7/20)^2$ of 5 × 60 s, i.e. about 35 s integration time is adequate.

There is, however, another factor to also consider: even a very localised heating rate should not be so high that there will be any risk of pain or injury during the time of integration. A suitable acceptable local temperature rise ~~may~~ can be set to 5 K, in consideration of both that the skin area with heat-sensing nerves will be heated at least by conduction and that such a temperature rise under short term conditions will not cause any injury in the fingers. A normal person will feel and react to a temperature increase of the same order or less – about 3 K – within some very few seconds.

A homogeneous SAR value of 20 W/kg (the basic restriction for **instructed person** fingers) will result in a temperature rise rate of about 0,5 K/min.

Now suppose that only e.g. the tip of a finger absorbs all power and the remainder of the 10 g absorbs no power. Such scenarios ~~must~~ shall actually be considered for **small area contacting applicators** dealt with in this standard and of course occurs e.g. with the finger if there is access to the near field. The volume of that part of the tip that absorbs microwaves is now set to 0,5 cm^3 (which is the volume of a hemisphere with diameter 12 mm). Using this in relation to the 10 cm^3 of the basic restriction, one obtains 20 times faster "allowed" temperature rise rate of 10 K/min. This will also mean that the person will feel the heating of the finger within 20 s. Since the equilibration by heat conduction has about the same time constant as above, one again arrives at about 30 s suitable integration time.

AA.6 Conclusions and modifications of differences to the existing standards for microwave ovens with a cavity door

The 6 min time of integration specified in many existing standards is inadequate for the purposes of this standard. A more realistic value should be 30 s. However, additional requirements on protection against accessibility to microwave-containing regions are also needed – and are contained in Clause 101 of this standard.

The existing emission standard for microwave ovens specifies an integration time of about 2 s for the measurement. This is for historical and practical rather than safety reasons. A typical household microwave oven has either a ceiling stirrer or a turntable, and with the specified circularly cylindrical test **load**, the leakage variation periodicity will be comparable to or less than the specified integration time. Measurements are then correct and made easily and quickly with the present standards for microwave ovens with a cavity door for user access.

Since the appliances considered in this standard behave quite differently, there is no reason to introduce limitations on construction which have no relevance to safety considerations. The same 20 s time of integration for leakage measurements as in IEC 60335-2-90 shall therefore be applied. This is somewhat shorter than 30 s, but allows faster measurements and easier integration. The most onerous 20 s interval is to be chosen, and the instrument integration time of 2 s to 3 s shall be maintained.

In addition, the same maximum measured (integrated, ceiling) value of 250 W/m^2 as in IEC 60335-2-90 for microwave tunnel ovens, consistent with the instrument integration time of 2 s to 3 s is introduced, to simplify instrument specifications and handling as well as the numerical integration in cases of highly variable leakage. Such strong variability ~~may~~ can occur for example in appliances with a protective device consisting of a built-in leakage monitor coupled to a cut-out.

Bibliography

The bibliography of Part 1 is applicable except as follows.

Addition:

IEC 60335-2-25, *Household and similar electrical appliances – Safety – Part 2-25: Particular requirements for microwave ovens, including combination microwave ovens*

IEC 60519-6, *Safety in ~~electroheat~~ installations for electroheating and electromagnetic processing – Part 6: ~~Specifications for safety in industrial microwave heating equipment~~ Particular requirements for high frequency dielectric and microwave heating and processing equipment*

IEC 60601-1, *Medical electrical equipment – Part 1: General requirements for basic safety and essential performance*

IEC 61010 (all parts), *Safety requirements for electrical equipment for measurement, control, and laboratory use*

IEC 60989:1991 [1], *Separating transformers, autotransformers, variable transformers and reactors*

[1] Withdrawn.

IEC 60335-2-110

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INTERNATIONAL STANDARD

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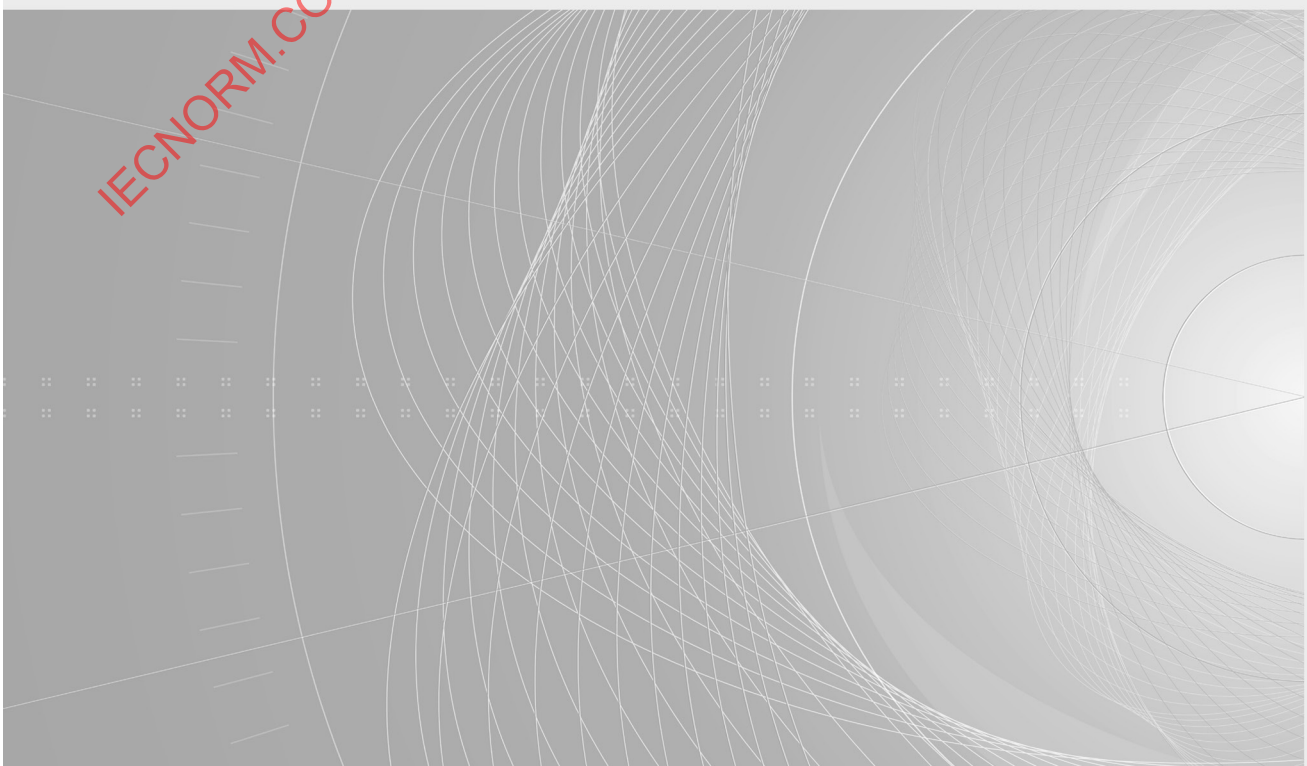
Household and similar electrical appliances – Safety – Part 2-110: Particular requirements for commercial microwave appliances with insertion or contacting applicators

Appareils électrodomestiques et analogues – Sécurité – Partie 2-110: Exigences particulières pour les appareils à micro-ondes à usage commercial avec applicateurs par insertion ou par contact



IEC 60335-2-110:2024-07(en-fr)

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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HOUSEHOLD AND SIMILAR ELECTRICAL APPLIANCES – SAFETY –

Part 2-110: Particular requirements for commercial microwave appliances with insertion or contacting applicators

FOREWORD

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IEC 60335-2-110 has been prepared by subcommittee 61B: Safety of microwave appliances for household and commercial use, of IEC technical committee 61: Safety of household and similar electrical appliances. It is an International Standard.

This second edition cancels and replaces the first edition published in 2013 and Amendment 1:2019. This edition constitutes a technical revision.

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

– Subclause 7.1 has been improved in clarity.
– Subclauses 19.11.2 and 19.103 have been improved in clarity.

– Clause 28 has been modified to add screw requirements.

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

Draft	Report on voting
61B/688/CDV	61B/691A/RVC

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 commercial microwave appliances with insertion or contacting applicators.

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

NOTE 2 The following numbering system is used:

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

NOTE 3 The following print types are used:

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

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

The committee has decided that the contents of this 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 and SC 61B supporting documents on the IEC website
https://www.iec.ch/tc61/supportingdocuments
https://www.iec.ch/sc61b/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 2-110: Particular requirements for commercial microwave appliances with insertion or contacting applicators

1 Scope

This clause of Part 1 is replaced by the following.

This part of IEC 60335 deals with the safety of microwave appliances intended for commercial use, their **rated voltage** being not more than 250 V for single-phase appliances connected between one phase and neutral and 480 V for other appliances.

As far as is practicable, this standard deals with the common hazards presented by these types of appliances.

Appliances covered by this standard incorporate an open-ended **applicator** (as example an overview is given in Figure 103) for treatment of the **load**. They are divided into three types:

– with **insertion applicator**, typically for moisture removal by insertion into holes in floors, walls or ceilings (an example is given in Figure 106);

– with **large area contacting applicator**, typically for drying of floors, walls or ceilings (examples are given in Figure 104 and Figure 105);

– with **small area contacting applicator**, typically for paint removal and spot-heating (an example is given in Figure 107).

Microwave appliances with **insertion applicator**, **large area contacting applicator** or **small area contacting applicator** are using electromagnetic energy in one or several of the ISM frequency bands between 300 MHz and 30 GHz, for supplying energy to an external load which is heated so that a resulting process of drying, moisture transport which can result in forces due to formation of steam, decomposition or chemical modification, melting, or termination of organisms such as bacteria or fungus occurs.

NOTE 101 ISM frequency bands are the electromagnetic frequencies established by the ITU and reproduced in CISPR 11.

NOTE 102 Food and beverages are not loads in the meaning of this standard.

Appliances with **insertion applicator** and with **large area contacting applicator** are **portable appliances**. Appliances with **small area contacting applicator** are **handheld appliances**.

Appliances that use non-electrical energy are within the scope of this standard. The microwave-related portion is considered **motor-operated**.

The rationales for the **microwave barrier** and associated leakage tests are described in informative Annex AA.

Attention is drawn to the fact that

– these appliances can radiate microwave energy outside a **restricted area** where they are used. The additional requirements specified by national authorities responsible for the protection for non-ionising radiation that the limit of power flux density is 10 W/m^2, averaged over any time period of 6 min, outside this **restricted area** is taken into consideration in this standard;

– these appliances are intended to exclusively treat the **load** in **normal operation**, i.e. this standard does not apply to appliances or systems employing free space microwave propagation;
– for appliances intended to be used in tropical countries, special requirements can be necessary;
– in many countries, additional requirements are specified by the national health authorities, and national authorities responsible for the protection of labour and for non-ionising radiation protection.

This standard does not apply to

– household microwave ovens, including combination microwave ovens (IEC 60335-2-25);
– commercial microwave ovens with a cavity door, commercial combination microwave ovens with a cavity door and commercial microwave ovens without a cavity door and with transportation means (IEC 60335-2-90);
– industrial microwave heating equipment (IEC 60519-6);
– appliances for medical purposes (IEC 60601-1);
– appliances and equipment for laboratory use (IEC 61010 series);
– appliances intended to be used in locations where special conditions prevail, such as the presence of a corrosive or explosive atmosphere (dust, vapour or gas);

Some of the specifications and tests in this standard are not applicable for other than 2 450 MHz appliances.

2 Normative references

This clause of Part 1 is applicable except as follows.

Addition:

IEC 60335-2-90, *Household and similar electrical appliances – Safety – Part 2-90: Particular requirements for commercial microwave ovens*

ISO 898-1, *Mechanical properties of fasteners made of carbon steel and alloy steel – Part 1: Bolts, screws and studs with specified property classes – Coarse thread and fine pitch thread*

ISO 3506-1, *Fasteners − Mechanical properties of corrosion-resistant stainless steel fasteners − Part 1: Bolts, screws and studs with specified grades and property classes*

ISO 3506-2, *Fasteners − Mechanical properties of corrosion-resistant stainless steel fasteners − Part 2: Nuts with specified grades and property classes*

ISO 3506-3, *Mechanical properties of corrosion-resistant stainless steel fasteners – Part 3: Set screws and similar fasteners not under tensile stress*

ISO 3506-4, *Mechanical properties of corrosion-resistant stainless steel fasteners – Part 4: Tapping screws*

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

ISO 7010, *Graphical symbols – Safety colours and safety signs – Registered safety signs*

3 Terms and definitions

This clause of Part 1 is applicable except as follows.

3.1 Definitions relating to physical characteristics

3.1.7

Note 101 to entry: The **rated frequency** is the input frequency.

3.1.9

Modification:

Replace the first paragraph by the following.

heating operation of the **appliance** under the following conditions:

The **appliance** is operated according to the manufacturer's instructions for **intended use**. However, using a typical **load** for **intended use** can be impractical, since it can be part of a building, unless the manufacturer makes useful and realistic such **loads** available for the tests. If that is not the case, the appliance is operated under the following conditions:

The initial temperature of the test **load** which is used for microwave energy absorption shall be (20 ± 5) °C.

The highest generator power settings are to be used.

Appliances with an **insertion applicator** for moisture removal are operated by insertion into holes in floor, wall or ceiling structures under the following conditions:

a) The test **load** consists of a metal tank filled with water, having an open top water surface exceeding that of the horizontal dimensions of the appliance by at least 70 mm on all sides and having a water column height of at least 150 mm plus the length of the longest insertion distance of the **insertion applicator**. At the top sides of the tank there are horizontal supports of a **microwave-transparent** material, with a suitable opening for the applicator antenna. The water level is adjusted so that the distance from the housing of the appliance to the test **load** is the same as in its **intended use**.

   Note 101 to entry: If it is obvious that good microwave impedance matching of the **insertion applicator** can be obtained only if the hole into which it is inserted is not water-filled, a sleeve or similar of a highly **microwave transparent** material such as PTFE is used around the **insertion applicator**. If wave propagation in the axial direction occurs in the test set-up and the manufacturer can show that it is not possible in actual use, or monitoring devices then shut down the **insertion applicator**, a thin-wall plastic tube with inner diameter corresponding to the maximum hole diameter according to the manufacturer's specification can be used.

b) Appliances with **large area contacting applicator** for drying of floor, wall or ceiling structures are operated under the following conditions: the test **load** consists of a metal tank filled with water, having an open top water surface exceeding that of the horizontal dimensions of the appliance by at least 70 mm on all sides and having a water column height of at least 150 mm. At the top of two opposite tank sides there are horizontal supports of a **microwave-transparent** material, extending just so far inwards that the **traction drive** rests on the support. The water level is adjusted so that the distance from the **applicator** to the test **load** is the same as in its **intended use**. The proper reversal function of the **traction drive** is tested under the following conditions: the appliance is operated on a horizontal plywood surface with a thickness of 20 mm and an area sufficient to allow back and forth movement between blocks representing walls.

   Note 102 to entry: If needed for representative operation of the appliance, the horizontal supports are extended as to activate the mechanical **microwave interlocks**.

Appliances with **small area contacting applicator** for paint removal and spot-heating are operated under the following conditions:

The test **load** consists of a grinding wheel or grinding block made of fine-grained silicon carbide at least 15 mm in thickness, and its length and width exceeding the corresponding dimensions of the **applicator** opening by at least 30 mm; however this test **load** shall be so large that it can be air-cooled from the underside without the appliance being influenced.

3.1.101
rated microwave power output
microwave power output assigned to the appliance by the manufacturer

Note 1 to entry: This can be lower than the **available microwave power**, due to intentional microwave power losses in microwave absorbers (see Note in 101.1) and coaxial cables acting for protection of the microwave generator of **small area contacting applicators** (see 22.101).

3.1.102
available microwave power
microwave generator nominal output under impedance matched condition which is obtained by the generator manufacturer specification and measurement of its electrical input to the generator in the appliance during the first 10 s of operation at maximum power

Note 1 to entry: Magnetrons will typically have a stationary power output 3 s after energising.

3.6 Definitions relating to parts of an appliance

3.6.101
applicator
structure which applies the microwave energy to the **load**

3.6.102
microwave transparent
property of a material having negligible absorption and reflection of microwaves

Note 1 to entry: The relative permittivity of a **microwave transparent** material is less than 7 and the relative loss factor is less than 0,015.

3.6.103
insertion applicator
applicator for insertion into the **load**, in which all **available microwave power** is intended to be absorbed

3.6.104
large area contacting applicator
applicator with a metallic enclosure, having at least one geometric non-metallic opening through which microwave energy is applied to a closely located external **load** in which all **available microwave power** is intended to be absorbed

3.6.105
small area contacting applicator
applicator with a metallic enclosure, having at least one geometric non-metallic opening or appropriate device through which microwave energy is applied to a very closely located external **load** in which all **rated microwave power** is intended to be absorbed

3.6.106
traction drive
means or system used to accomplish movement of an appliance with **large area contacting applicator** on a floor

3.6.107
microwave enclosure
overall structure that is intended to confine the microwave energy

Note 1 to entry: Barriers mounted outside the **microwave enclosure** are not considered a part of it.

3.6.108
microwave barrier
microwave transparent part of the microwave appliance that is mounted outside the **microwave enclosure** for limiting access into it and can only be removed with the aid of **tools**

Note 1 to entry: A **microwave barrier** can be mounted between the **microwave enclosure** and the external cover of the appliance.

Note 2 to entry: Devices such as an array of metal chains or hinged metal plates at the periphery of the opening of an **applicator** intended to reduce microwave leakage are not considered **microwave barriers**.

Note 3 to entry: **Microwave barriers** cannot be hinged or flexed.

3.6.109
microwave guard
constructive part of the appliance that is mounted outside or at the **microwave enclosure** for reducing microwave leakage by shielding and/or absorption and can only be removed with the aid of **tools**

Note 1 to entry: **Microwave guards** can move or open when the **applicator** is brought into contact with the **load**.

Note 2 to entry: Devices such as an array of metal chains or hinged metal plates at the periphery of the opening of an **applicator** intended to reduce microwave leakage are considered **microwave guards**.

3.6.110
maintenance door
constructive part of the appliance that can be opened or removed with the aid of **tools** to get access for service and repair

3.6.111
microwave interlock
device or system that prevents the operation of the microwave generator if conditions of microwave leakage occur or are likely to occur

Note 1 to entry: Examples of **microwave interlock** are switches which stop the microwave power when a contacting **applicator** is lifted up or an **insertion applicator** is removed from its **load** during operation, and an integral leakage monitor which does the same if there is insufficient proximity between an **applicator** and the **load** or if an attempt is made to start the appliance without a **load**.

3.6.112
viewing opening
opening into the **applicator** through which the treatment can be visually monitored

3.8 Definitions relating to miscellaneous matters

3.8.101
load
object to be treated into which the **applicator** is introduced or put in close position to

3.8.102
instructed person
person who is instructed and monitored to know how to avoid any danger caused by the operation of a microwave appliance with **insertion applicator**, **large area contacting applicator**, or **small area contacting applicator**

3.8.103
skilled person
person with professional education, knowledge and experience to discern and to avoid any danger caused by the operation of a microwave appliance with **insertion applicator**, **large area contacting applicator**, or **small area contacting applicator**

3.8.104
ordinary person
person who is neither a **skilled person** nor an **instructed person**

3.8.105
intended use
any use of the appliance which is foreseeable, as described in the user instructions, and which is consistent with such activities as operating, starting, stopping, connecting to or disconnecting from the supply mains

3.8.106
user control
any **control** device requiring the operator's actuation to perform specific functions

3.8.107
restricted area
space where the operation of the equipment takes place, plus any area outside this where the exposure level from the equipment exceeds 10 W/m^2, averaged over any 6 min

Note 1 to entry: The **restricted area** is determined by measuring the microwave leakage through floor, wall or ceiling structures of the treatment zone. The thickness of the **load** in the radially outgoing direction from the **applicator** is considered only if the **load** is accessible from behind for microwave leakage measurements in **normal operation**.

3.8.108
biased-off switch
switch that automatically returns to the **off-position** when its actuating member is released

3.8.109
start switch
biased-off switch that shall be actuated by the operator before the **operation switch** will function

3.8.110
operation switch
biased-off switch designed so that it will automatically disconnect the microwave generator or the supply main circuit when the operator's actuating force is removed

4 General requirement

This clause of Part 1 is applicable except as follows.

4.101 Instead of the requirements on supervision of the **microwave interlocks** by monitored **microwave interlocks** as in IEC 60335-2-90, this standard applies the concepts of **restricted area** and microwave leakage checks of **microwave interlock** function for **large area contacting applicators** and **insertion applicators** – and **start switch** as well as **operation switch** for **small area contacting applicators**.

5 General conditions for the tests

This clause of Part 1 is applicable except as follows.

5.3 *Modification:*

Instead of carrying out the tests in the order of clauses, the following sequence of clauses and subclauses applies: Clause 32, 22.107, Clause 101, Clauses 7 to 17, Clause 20, Clause 21, Clause 18, Clause 19, Clause 22 (except 22.107), Clauses 23 to 31.

NOTE 101 Clause 101 deals with the protection against leakage by basic design of **microwave enclosures**; Clause 22 deals with the additional requirements applicable when handling and against improper handling of the appliance, and against other hazards caused by the microwaves; 32.1 deals with the leakage measurement instrumentation and handling, plus limiting values.

5.101 The microwave-related portion of the appliance is considered **motor-operated**.

6 Classification

This clause of Part 1 is applicable except as follows.

6.1 *Modification:*

Microwave appliances shall be **class I**.

6.2 *Addition:*

Large area contacting applicators and **insertion applicators** shall be at least IPX1. **Small area contacting applicators** shall be at least IPX5.

7 Marking and instructions

This clause of Part 1 is applicable except as follows.

7.1

Modification:

Add the following new dashed item and text before the last dashed item of the first list of Part 1:

– substance of the following warnings, if applicable:
  - WARNING: Switch off and remove plug from mains before adjusting, cleaning or if the cord is entangled or damaged.
  - WARNING: Keep the flexible supply cord away from the microwave-energised parts.

Addition:

Where appropriate IEC/ISO symbols or pictograms are available, they can be used.

Modification:

Add the following new text before the compliance paragraph:

Where appropriate, appliances shall be marked with symbols ISO 7000-0434A (2004-01) and IEC 60417-6167 (2012-07).

Appliances shall be marked with the nominal frequency in megahertz of the ISM band in which they operate.

Appliances shall be marked with the **rated microwave power output**.

Appliances shall be marked on an affixed inspection tag or label, with the date when the latest complying microwave leakage and function test in accordance with the service manual was carried out.

Compliance is checked by inspection.

7.6 *Addition:*

	[symbol IEC 60417-6166 (2012-07)]	caution, non-ionizing electromagnetic radiation; caution, microwave radiation
	[symbol IEC 60417-6167 (2012-07)]	keep out of microwave radiation
	[symbol ISO 7010-P004 (2011-05)]	no thoroughfare

7.12 *Addition:*

The instructions shall include the substance of the following.

– WARNING: If **microwave barriers** or **microwave guards** are damaged, the appliance must not be operated until repairs by a **skilled person** have been carried out;

– WARNING: It is hazardous for anyone other than a **skilled person** to carry out any service or repair operation that involves the removal of any cover or barrier which gives protection against exposure to microwave energy;

– if smoke is observed, switch off or unplug the appliance;

– failure to maintain the appliance in a clean condition could lead to deterioration that could adversely affect the life of the appliance and possibly result in a hazardous situation;

– the appliance shall not be cleaned with a water jet.

Appliances shall be operated only by **instructed persons** or **skilled persons**.

An instruction sheet shall be supplied with the appliance.

The instructions shall include:

a) those warnings required to be marked on the appliance together with further explanation, where appropriate;

b) specifications of the load surface irregularities (non-flatness) with which the appliance may be used;

c) that the appliance shall not be used in standing water;

d) advice on the use and type of extension cords to be used (not lighter than required in 25.7);

e) instructions for fitting and use of attachments, if any;

f) the substance of the following, where appropriate:

WARNING: If parts of **viewing openings**, **microwave barriers**, **microwave guards**, the housing or any other means named by the manufacturer are damaged, the appliance shall not be operated until it is repaired by a **skilled person**. Until repairs are carried out, the appliance shall be set in a permanent non-operational condition (e.g. with key switch, code-card or similar devices). Further details are included in the instructions for use.

The **instructed persons** shall regularly, but at a minimum of once a year, be instructed by a **skilled person**. A record of the instruction provided shall be required.

1) Training
   - Read the instructions. Be familiar with the **user controls** and the use of the appliance.
   - Never allow **non-instructed persons** to use the appliance.
2) Preparation
   - Inspect all areas where the appliance is to be used and remove all foreign objects.
3) Operation
   - Operate the appliance only in daylight or in good artificial light.
   - The main switch key shall not be left with the appliance when it is unattended.
   - The key shall be stored in a safe place.
   - Use extreme caution when reversing or pulling an operating **insertion applicator** or **large area contacting applicator** towards you.
   - Overheating of potentially flammable **loads** such as wood and some composite materials can be locally and internally heated to charring, which can in turn cause the microwave absorption rate to increase so that a fire occurs. The microwave power setting needs to be reduced and the treatment shall be constantly attended. Attention shall also be paid to the risk of a delayed hazardous condition.
   - If smoke is observed, switch off the appliance, contain the fire by an extinguisher, pay attention to the risk of recurrence and see to it that the overheated region does not expand to unattended spaces.
   - Never operate the appliance with defective **microwave barriers** or **microwave guards**, or without other safety devices in place.
   - Switch on the appliance according to instructions and with all parts of your body which are not used for handling of the appliance well away from the **applicator**.
   - Do not put hands or feet near or under **applicators**, **microwave barriers** or **microwave guards**.
   - Pull the plug from the socket:
     – before clearing a blockage;
     – before checking, cleaning or working on the appliance;
     – after striking a foreign object. Inspect the appliance and, if damaged, do not operate it until it has been repaired by a **skilled person**.

7.14 *Addition:*

The warnings specified in 7.12 shall be in lettering at least 3 mm high.

The warnings specified in 7.101 and 7.102 shall be in lettering at least 5 mm high.

The letters of the substance of the warnings of the penultimate dashed item of the first list of 7.1, which can be in upper or lower case, shall be a minimum of 5 mm high, in black on a yellow background.

The height of the triangle of symbol ISO 7000-0434A (2004-01) and the height of symbol IEC 60417-6167 (2012-07) shall be at least 50 mm.

The diameter of symbol ISO 7010-P004 (2011-05) and the height of the triangle of symbol IEC 60417-6166 (2012-07) required by 7.102 shall be at least 150 mm.

Symbols ISO 7000-0434A (2004-01), IEC 60417-6166 (2012-07) and ISO 7010-P004 (2011-05) shall comply with ISO 3864-1, but only with the specified colour requirements.

7.15 *Addition:*

The substance of the warnings of the penultimate dashed item of the first list of 7.1 shall be placed in a prominent position on the appliance.

Symbol ISO 7000-0434A (2004-01) and symbol IEC 60417-6167 (2012-07) shall be placed adjacent to each other in a location where any **microwave barrier** or **microwave guard** is visible, or near the opening in the **microwave barrier** of a **contacting applicator** under which there is a **load**.

The same symbols shall be placed at **viewing openings** with holes larger than diameter 12 mm and which are not protected by visually transparent protective devices.

Markings or symbols giving cautionary information shall be located close to the hazard.

7.101 The service or repair manual shall include the substance of the following:

– WARNING: The appliance shall comply with requirements of Clause 101 and 32.1 after every repair and according to the instructions of the manufacturer.

Attention: Persons shall not be exposed to excessive emitted microwave energy from the microwave generator. All connections, waveguides, flanges, seals, contacts, etc. of the **applicator**, **microwave enclosure**, **microwave barriers** and **microwave guards** shall be safely constructed so that the microwave leakage does not exceed the allowed limit. Operation of the appliance without a microwave absorbing **load** shall be avoided. The appliance shall be regularly maintained and kept in a good condition to ensure that microwave leakage does not exceed the allowed limit.

In addition, the service manual shall specify the following:

– the presence of user instructions is to be checked;
– a microwave leakage check is to be made at least every 100 h of usage or at shorter intervals, which shall be stated in the service manual;
– when the microwave leakage check is made, all **microwave interlocks** are to be checked and a test of the proper function of any built-in leakage monitor being a part of a **microwave interlock** is also made according to instructions which shall be given in the service manual;
– that the appliance shall be marked on an affixed inspection tag or label, with the date when the latest complying microwave leakage and function test in accordance with the paragraph above was carried out.

NOTE A test of a built-in leakage monitor can be made firstly by disabling its 20 s time constant, then making other **microwave interlocks** inoperable and then finally slowly lifting the **large area contacting applicator** during **normal operation**. **Insertion applicators** are tested in the same manner.

7.102 The following operator instructions apply for protection of the general public against excessive microwave exposure when operating appliances with **insertion applicator** or **large area contacting applicator**:

– The operator shall have access to an instrument according to 32.1.

– Inspect the walls, floors or ceilings that are to be treated for the presence of metal objects such as long nails, electrical cables, water pipes and air ducts. These can firstly create local overheating and secondly act as antennas and transport microwave energy along. The microwave power setting need to be reduced and particular attention is to be paid to possible microwave leakage outside what is typically considered the **restricted area**.

– Ensure that only the operator can be present in the **restricted area**.

– The boundaries of the **restricted area** are determined by measuring the power flux density with an instrument as specified in 32.1. An initial measurement series is made with the appliance located in the most onerous position with respect to expected boundaries of the **restricted area**. The instrument time constant of 2 s to 3 s is then used. The locations where the largest readings have been made are then to be re-examined, using a longer averaging time up to 6 min.

– Any measurement results shall be recorded in a journal for each job in the same building. In addition to the journal, a plot of the location(s) of the appliance shall be included as well as the point of measurements. For this purpose a copy of the plan drawing may be used.

– Since the boundaries of the **restricted area** can change during **normal operation**, the boundaries shall be re-determined by several measurements of power flux density with an instrument as specified in 32.1.

– In case of doubt or missing relevant information about the construction of the building, the **restricted area** shall be enlarged.

NOTE Examples for how to make the **restricted area** inaccessible are: locking of doors of rooms lying in the **restricted area** or setting up a barrier installation. The mechanical stability requirements on barrier installations are under consideration. However, it is not possible to insert test probe B of IEC 61032 through the barrier installation.

– The **restricted area** shall be made inaccessible and be clearly marked with symbol ISO 7010-P004 (2011-05) and symbol IEC 60417-6166 (2012-07).

Compliance is checked by inspection.

8 Protection against access to live parts

This clause of Part 1 is applicable except for the application of test probe 18 of IEC 61032.

9 Starting of motor-operated appliances

This clause of Part 1 is applicable except as follows.

9.1 *Addition:*

Motors of the **traction drive** shall start under all voltage conditions that can occur in use.

*Compliance is checked by starting the motor three times at a voltage equal to 0,85 times **rated voltage**, the motor being at room temperature at the beginning of the test.*

*The motor is started each time under the conditions occurring at the beginning of **normal operation** or, for automatic appliances, at the beginning of the normal cycle of operation. The motor shall be allowed to stop between successive starts. For appliances provided with motors having other than centrifugal starting switches, the test is repeated at a voltage equal to 1,06 times **rated voltage**.*

In all cases, the motor shall start and it shall function in such a way that safety is not affected and overload protection devices of the motor shall not operate.

10 Power input and current

This clause of Part 1 is applicable.

11 Heating

This clause of Part 1 is applicable except as follows.

11.7 *Modification:*

*Appliances with a **contacting applicator** for drying of floor, wall or ceiling structures, and appliances with an **insertion applicator** for moisture removal by insertion into holes in floor, wall or ceiling structures are operated as specified in 3.1.9 until steady conditions are established.*

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.

14 Transient overvoltages

This clause of Part 1 is applicable.

15 Moisture resistance

This clause of Part 1 is applicable.

16 Leakage current and electric strength

This clause of Part 1 is applicable except as follows.

16.101 The windings of the power transformer that supplies the magnetron shall have adequate insulation.

Compliance is checked by one of the following tests.

– *For switch-mode power suppliers, the insulation between the primary and secondary windings of switch-mode power supply transformers is subjected for 1 min to a voltage of substantially sinusoidal waveform and having a frequency of 50 Hz or 60 Hz. The value of the voltage is 1,414 times the peak value of the secondary **working voltage** plus 750 V, with a minimum of 1 250 V.*

There shall be no breakdown between windings or between adjacent turns of the same winding.

– *For other power transformer, twice the **working voltage** is induced in the secondary winding of the transformer by applying a sinusoidal voltage having a frequency higher than **rated frequency** to the primary terminals.*

The duration of the test is

- *60 s, for frequencies up to twice the **rated frequency**, or*
- $120 \times \frac{\textbf{rated frequency}}{\textit{test frequency}}$ *s, with a minimum of 15 s, for higher frequencies.*

NOTE The frequency of the test voltage is higher than the **rated frequency** to avoid excessive excitation current.

A maximum of one-third of the test voltage is applied and is then rapidly increased without creating transients. At the end of the test, the voltage is decreased in a similar manner to approximately one-third of its full value before switching off.

There shall be no breakdown between windings or between adjacent turns of the same winding.

17 Overload protection of transformers and associated circuits

This clause of Part 1 is applicable except as follows.

Addition:

The tests are not carried out on the power transformer that supplies the magnetron and its associated circuits; these are checked during the tests of Clause 19.

18 Endurance

This clause of Part 1 is replaced by the following.

Microwave barriers, **microwave guards** and other associated parts shall be constructed to withstand wear that can be expected in normal use.

Compliance is checked by the following test.

***Microwave barriers**, **microwave guards** and other associated parts that are manipulated or accessed by an **instructed person** multiple times on a daily basis for inspection, **load** correction or similar shall be subjected to 10 000 cycles of operation.*

***Microwave barriers**, **microwave guards** and other associated parts that are regularly manipulated or accessed for servicing purposes on a daily basis or less shall be subjected to 300 cycles of operation.*

If there are more than one identical such barrier, guard or similar, only one is tested.

The number of operations is 6 cycles per 1 min or the maximum quantity that is given for the construction.

*After the test, the microwave leakage shall not exceed the limit specified in 32.1 and **microwave barriers**, **microwave guards** and other associated parts shall still function.*

NOTE 101 **User controls** can be rendered inoperative in order to carry out the test.

NOTE 102 Components, the deterioration of which does not impair compliance with this standard, can be replaced in order to complete the test.

19 Abnormal operation

This clause of Part 1 is applicable except as follows.

19.11.2 *Addition:*

The cathode to anode circuit of a magnetron is open-circuited and short-circuited one at a time. If one of these fault conditions results in an input current that increases with decreasing voltage, the test is carried out with the appliance supplied at 0,94 times ***rated voltage****. However, if the input current increases more than proportionally with voltage, the appliance is supplied at 1,06 times* ***rated voltage****.*

The filament of a magnetron is not short-circuited.

19.101 *The* ***traction drive*** *of appliances with* ***contacting applicator*** *is defeated and the appliance is then operated on a horizontal metal surface exceeding that of the horizontal dimensions of the appliance by at least 70 mm on all sides, instead of the normal* ***load****.*

The period of operation is the maximum time allowed by the timer or until steady conditions are established, whichever is shorter.

The test in 32.101 is then made, without rod.

19.102 *Appliances with* ***large area contacting applicator*** *or* ***small area contacting applicator*** *are operated with* ***user controls*** *set at the most unfavourable position and placed on a horizontal metal surface exceeding that of the horizontal dimensions of the appliance by at least 70 mm on all sides, instead of the normal* ***load****.*

Appliances with ***small area contacting applicator*** *are in addition operated with* ***user controls*** *set at the most unfavourable position and held in free space, instead of at the normal* ***load****.*

Appliances with ***insertion applicator*** *are operated with* ***user controls*** *set at the most unfavourable position and placed in a metal tube with a metal bottom and a metal ring at the side of insertion with a diameter and length exceeding the dimensions of the part of the appliance intended to be inserted, instead of the normal* ***load****.*

The period of operation of appliances is the maximum time allowed by the timer or until steady conditions are established, whichever is shorter.

The test in 32.101 is then made, without rod.

19.103 *Appliances are operated under* ***normal operation*** *with the timer or other* ***user controls*** *that operate in normal use short-circuited. If the appliance is provided with more than one* ***user control****, these are short-circuited in turn. These short-circuits are applied one at a time.*

19.104 *Appliances are operated under* ***normal operation*** *and with any single-fault condition simulated that is likely to occur. The* ***controls*** *are adjusted to their most unfavourable setting and appliances with* ***contacting applicator*** *and* ***insertion applicator*** *are operated for the maximum time allowed by the timer or stationary conditions or 90 min, whichever is shorter.*

NOTE Examples of fault conditions are

– blocking of air openings in the same plane;

– locking the rotor of motors if the locked rotor torque is smaller than the full **load** torque;

– locking moving parts liable to be jammed.

19.105 *The position switches of the reversal **control** of the **traction drive** of appliances with **large area contacting applicator** are defeated and the appliance is then operated as in 3.1.9.*

The period of operation is the maximum time allowed by the timer or until steady conditions are established, whichever is shorter.

20 Stability and mechanical hazards

This clause of Part 1 is applicable except as follows.

20.1 *Addition:*

***Maintenance doors** which can be opened, lids and accessories shall be placed in the most unfavourable position.*

20.2 *Addition after the first paragraph:*

This is also to be applied on operating elements i.e. handles or hand wheels.

Modification:

The test probe 18 of IEC 61032 is not applicable.

20.101 Protective enclosures according to 20.2 shall not be **detachable** except where

– an appropriate interlock prevents operation of motors or fans without protective enclosures;
– it is a solid part of the housing of the appliance.

Compliance is checked by inspection.

21 Mechanical strength

This clause of Part 1 is applicable except as follows.

21.101 *Appliances with **large area contacting applicator** for a horizontal **load**, and with **insertion applicator** intended for vertical insertion are placed on a rigid floor, as in normal use.*

*A force of 140 N or the maximum force that can be applied without tilting the appliance, whichever is smaller, is then applied in a direction perpendicular to the **load** surface, to the free edges of **microwave barriers** and non-movable **microwave guards**.*

This test is carried out 10 times. There shall be no mechanical deformation.

*Appliances with **large area contacting applicator** for a vertical **load**, and with **insertion applicator** intended for horizontal insertion are placed against a rigid wall, as in normal use. A force corresponding to 4 times the mass of the appliance is then applied vertically to the outer part of the appliance and then vertically to the free edges of **microwave barriers** and non-movable **microwave guards**, for 1 min.*

The appliance shall not fall down. It shall also comply with 32.1.

*Handheld **small area contacting applicators** are placed against a rigid object, as in normal use. A force of 140 N is then applied axially, for 1 min.*

There shall be no mechanical deformation.

21.102 *The outside surface of **microwave barriers** and **microwave guards** and visually transparent protective devices over or inside **viewing openings** of appliances with **large area contacting applicator** and with **insertion applicator** are subjected to three impacts, each having an energy of 3 J. These impacts are applied to the central parts of the barriers and may be at the same point.*

The impact is applied by means of a steel ball having a diameter of 50 mm and a mass of approximately 0,5 kg. The ball is suspended by a suitable cord that is held in the plane of the barrier. The ball is allowed to fall as a pendulum through the distance required to strike the surface with the specified impact energy.

*Openable **microwave guards** are then opened and their inner surfaces are subjected to three similar impacts.*

NOTE The test is not made at accessible locations with removed **microwave barriers**.

*Any chokes and microwave absorbers on **microwave guards** are further tested by being subjected to three similar impacts. The impacts are made at three different locations.*

*Appliances with **small area contacting applicator** are held as in normal use. The outside surface of **microwave guards** of appliances with **small area contacting applicator** is subjected to a force of corresponding to 5 times the mass of the appliance or 20 N, whichever is smaller.*

The appliance shall then comply with 32.1.

21.103 *The power supply of the **small area contacting applicator** is placed in any position up to 1 m above the floor allowing the **small area contacting applicator** to fall down on a hardwood base having a thickness of 50 mm and being located where the **applicator** will hit it when dropped from a height of 1 m above the floor, with the cord to the power supply intact.*

*The **applicator** is then dropped onto the hardwood base.*

*This test is carried out five times, attempting to position the **applicator** so that its major axis is horizontal and so that a different part of it is exposed to the impact each time.*

*The **applicator** is then dropped five times attempting to position with its major axis vertically, with its active end pointing downwards.*

*The **applicator** shall not be damaged to such an extent that compliance with this standard is impaired, and in particular with regard to Clause 8 and 32.1.*

21.104 *The outside surface of **large area contacting applicators** and accessible **insertion applicators** positioned as in normal use are subjected to three impacts, each having an energy of 3 J. These impacts are applied to the most onerous parts and may be at the same point.*

The impact is applied by means of a steel ball having a diameter of 50 mm and a mass of approximately 0,5 kg. The ball is suspended by a suitable cord. The ball is allowed to fall as a pendulum through the distance required to strike the surface with the specified impact energy.

The appliance shall then comply with 32.1.

22 Construction

This clause of Part 1 is applicable except as follows.

22.40 *Addition:*

The switch shall have provisions for locking, such as a key or a key switch.

22.101 **Insertion applicators** and **large area contacting applicators** shall have an **available microwave power** of 2 000 W or less.

Small area contacting applicators shall have an effective microwave power of 200 W or less.

Compliance is checked by inspection and relevant measurements.

*The effective microwave power is calculated or measured at the feedthrough for coaxial line and **control** wiring (see key 9 in Figure 107) as follows:*

– *if there is a coaxial line between the microwave power generator and the **small area contacting applicator**, the losses in this coaxial line are to be measured or calculated under the condition of 25 % reflected power by means of conventional microwave methods;*

– *if there is a microwave isolator or a protective two-port attenuator between the microwave power generator and the **small area contacting applicator**, the manufacturer is allowed to use such data to increase the **available microwave power** under conditions of **normal operation**.*

22.102 **Large area contacting applicators** for drying of floor, wall or ceiling structures shall not have a smaller **applicator** opening than 1 cm^2 per W of **available microwave power**.

NOTE A minimum square opening is thus 35 × 35 cm for 1 200 W **available microwave power**.

Compliance is checked by inspection.

22.103 **Small area contacting applicators** shall not have a smaller **applicator** opening than 0,05 cm^2 per W of effective microwave power.

NOTE A minimum rectangular opening is thus 8 cm × 1 cm for 160 W effective microwave power.

Compliance is checked by inspection.

22.104 **Contacting applicators** for drying of floor, wall or ceiling structures equipped with automatic movement means of operation shall be provided with **controls** so that microwave generation is stopped when the appliance movement stops.

Compliance is checked by inspection of the appliance and its circuit diagram, and by relevant measurements and tests.

22.105 Appliances with **large area contacting applicator** and **insertion applicator** shall be provided with a means such that damage to the **supply cord** due to movement of the appliance, and appliance movement over **the supply cord**, are prevented as far as possible. The means provided shall be re-usable.

This requirement is considered to be met by, for example,

– a cord-retaining device to keep the **supply cord** out of the vicinity of the **microwave enclosure**, with the **supply cord** being fastened to the appliance;
– the **supply cord** entry or attachment being at least 0,6 m from the nearest point of the **microwave enclosure**;
– mechanical guards being designed into the **microwave barrier**;
– expandable springs to which the cord is fastened or automatic cord reels or equivalent which are fixed above the floor.

Compliance is checked by inspection and by the following test procedure, except for automatic cord reel-in devices.

*The **supply cord** as delivered with the appliance is attached to the device in accordance with the instruction manual. The **supply cord** is then subjected 10 times to a pull of 100 N, the pull being applied in the most unfavourable direction, without jerks, for 1 s.*

*After the test, the power **supply cord** shall show no damage within the meaning of this standard and it shall not have been displaced longitudinally, in the device, by more than 2 mm.*

Appliances with **small area contacting applicator** shall be provided with a means such that damage to the grounded flexible cable containing a coaxial line and **control** wiring due to moving and turning the appliance is prevented as far as possible.

This requirement is considered to be met by, for example,

– a cord-retaining device to keep the grounded flexible cable containing coaxial line and **control** wiring out of the vicinity of the guard, with the grounded flexible cable containing coaxial line and **control** wiring being fastened to the appliance, or
– the grounded flexible cable containing coaxial line and **control** wiring entry or attachment being at least 0,2 m from the nearest point of the guard.

Compliance is checked by inspection.

22.106 Maintenance doors and lids with hinges shall be constructed so that they cannot fall down unintentionally.

Compliance is checked by inspection.

22.107 Appliances with **large area contacting applicator** and with **insertion applicator** shall incorporate at least two **microwave interlocks** that are operated when the **applicator** is moved away from the **load**. Each of these interlocks shall operate before undue microwave leakage occurs and at least one of the interlocks shall operate by mechanical means.

Compliance is checked by inspection and the following test:

*All **microwave interlocks** except one are rendered inoperative. The appliance is supplied at **rated voltage** and operated with the **load** specified in 101.1.1 or 101.1.3. The microwave leakage is measured during the movement of the appliance.*

*The appliance shall comply with 32.101. The test is repeated on each **microwave interlock** in turn. Two test types are made: a first with a very slow movement away from the **load**, and a second test type with a very rapid movement away from the **load**. In the second case, the microwave generator shall be switched off within 3 s.*

NOTE 1 A **microwave interlock** can function by a microwave energy sensing device.

NOTE 2 **Microwave interlocks** are only tested if they are necessary for compliance with 22.107.

22.108 At least one **microwave interlock** shall incorporate a switch or an equally reliable method which disconnects the microwave generator or its supply main circuit.

Compliance is checked by inspection.

22.109 At least one of the **microwave interlocks** shall be concealed and not operable by manipulation. This **microwave interlock** shall operate before any accessible **microwave interlock** can be defeated.

Compliance is checked by the following test.

*The appliance is moved or not and an attempt is made to operate the concealed **microwave interlock** by applying test probe B of IEC 61032 to all openings. A straight rod, as shown in Figure 101, is also applied to any openings of the **microwave interlock** mechanism.*

*The appliance is moved and simultaneously an attempt is made to defeat any accessible **microwave interlock** by means of test probe B of IEC 61032.*

*It shall not be possible to operate the concealed **microwave interlock** during the tests.*

22.110 The failure of any single electrical or mechanical component that affects the operation of a **microwave interlock** shall not cause any other **microwave interlock** to become inoperative.

Compliance is checked by inspection and, if necessary, by simulating component failure and operating the appliance as in normal use.

22.111 A single fault such as failure of **basic insulation** or a loose wire bridging the insulation system shall not allow operation of the microwave generator when the **applicator** is moved away from the **load**.

*Compliance is checked by inspection and, if necessary, by simulating relevant faults. Wires that can become loose are disconnected and allowed to fall out of position but are not otherwise manipulated. They shall not come into contact with other **live parts** or earthed parts if this results in all **microwave interlocks** becoming inoperative.*

NOTE 1 Failure of **reinforced insulation** or **double insulation** is considered to be two faults.

NOTE 2 Wires secured by two independent fixings are not considered likely to become loose.

22.112 **Microwave interlocks** operated by **detachable parts** shall be guarded so that accidental operation is prevented.

Compliance is checked by inspection and by manual test.

22.113 Lights, switches or push-buttons for the indication of danger, alarm or similar situations shall be coloured red.

Compliance is checked by inspection.

22.114 In order to protect the **instructed person** during determination of the **restricted area** specified in 7.102, appliances with **large area contacting applicator** and **insertion applicator** shall be provided with a key switch or similar to operate it from a distance at which the power flux density is in conformity with 32.1.

NOTE This requirement ensures that the **instructed person** only gets closer to the operating appliance with **large area contacting applicator** and **insertion applicator** as long as the power flux density is in conformity with 32.1.

Compliance is checked by inspection.

22.115 **Insertion applicators** and **contacting applicators** without **traction drive** shall be provided with a timer limiting the time of operation to a value determined by **the instructed person**.

Compliance is checked by inspection.

22.116 The handheld unit of appliances with **small area contacting applicators** shall be provided with a **start switch** and an **operation switch**.

Compliance is checked by inspection.

22.117 **Small area contacting applicators** shall incorporate a stand.

Compliance is checked by inspection.

23 Internal wiring

This clause of Part 1 is applicable.

24 Components

This clause of Part 1 is applicable except as follows.

24.1

NOTE 101 IEC 60989 is not applicable to power transformers that supply the magnetron.

24.1.4 *Addition:*

Interlocks are subjected to the following test which is carried out on six samples.

The interlocks are connected to a ***load*** *that simulates the conditions occurring in the appliance when it is supplied at* ***rated voltage****. They are operated at a rate of approximately six cycles per minute. The number of cycles is*

– ***microwave interlocks on microwave guards*** *50 000;*
– *other interlocks:* *5 000.*

After the test, the interlocks shall not be damaged to such an extent that their further use is impaired.

25 Supply connection and external flexible cords

This clause of Part 1 is applicable except as follows.

25.1 *Modification:*

Appliances shall not be provided with an appliance inlet.

25.5 *Modification:*

Type X attachments shall not be used.

25.7 *Replacement:*

Supply cords shall not be lighter than

– if rubber insulated, ordinary tough rubber sheathed flexible cord (code designation 60245 IEC 53);
– if polyvinyl chloride insulated, ordinary polyvinyl chloride sheathed flexible cord (code designation 60227 IEC 53).

In some countries, these **supply cords** are not suitable and the **supply cord** shall be ordinary polychloroprene sheathed flexible cord (code designation 60245 IEC 57).

Compliance is checked by inspection.

NOTE 101 A requirement to use **supply cords** with an outer metal-braided sheath is under consideration.

25.14 *Addition:*

This requirement also applies to external cables or cords where, because of the design of the appliance, there is relative movement of more than 45° of the cable or cord at its point of entry into an enclosure.

25.15 *Addition:*

This requirement applies to all accessible cables or cords.

Replacement of the fourth paragraph:

A mark shall be made on the cord on the appliance side of the cord anchorage while it is subject to the pull force shown in Table 12, at a distance of approximately 2 cm from the cord anchorage or other suitable point. If access to the appliance side of the cord anchorage is not practicable then the mark shall be made on the supply side of the anchorage and it shall be ensured that the pull force is applied to the cord in such a way that, at the point of application of the force, the sheath of the cord does not move with respect to the conductors or their insulation.

Modification:

*The pull force on the **supply cord** shall be 150 N.*

26 Terminals for external conductors

This clause of Part 1 is applicable.

27 Provision for earthing

This clause of Part 1 is applicable except as follows.

27.101 Any external interconnection cable(s) between a separate main power supply (supplies) in a separate enclosure and the **applicator** portion in a separate enclosure shall include an additional earthing wire for high voltage circuits. The insulation of the wire shall correspond to the requirements for insulation for operating high voltage.

27.102 Any secondary (high voltage) circuit earthing of magnetrons by a separate wire shall be connected to its waveguide in such a way that the wire does not come loose during service or repair.

28 Screws and connections

This clause of Part 1 is applicable except as follows.

28.1 *Addition:*

Screws made of carbon steel and alloy steel shall be made in accordance with ISO 898-1.

Screws made of corrosion-resistant stainless-steel shall be made in accordance with ISO 3506-1 or ISO 3506-2 or ISO 3506-3 or ISO 3506-4.

28.4 *Addition:*

Screws that make mechanical connections and electrical connections shall be so designed that the contact pressure does not change appreciably through loosening of the screwed assembly parts during operational stress and contact corrosion.

Screws that make mechanical connections and provide earthing continuity shall

– be one of types specified in Table 101 and be made in accordance with ISO 898-1 or ISO 3506-1 or ISO 3506-2 or ISO 3506-3 or ISO 3506-4, and
– have a minimum outer thread diameter of 2,8 mm, and
– be so designed that the contact pressure does not change appreciably through loosening of the screwed assembly parts due to operational stress and contact corrosion. They shall be designed so that a minimum contact pressure remains.

Compliance is checked by inspection and by measuring the assembling torques for screwed connections providing earthing continuity by applying a torque as specified in Table 101 to turn the screw in the fastening direction. The screw shall not turn.

The screw shall not have been unfastened prior to performing this test.

Table 101 – Assembling torques for screwed connections providing earthing continuity

Outer thread diameter of the screw mm	**Assembling torque** Nm	
	Screwed connections for the mechanical strength of the screws A2-70 according to ISO 3506-1, or ISO 3506-2, or ISO 3506-3, or ISO 3506-4 and 5.8 according to ISO 898-1	**Screwed connections for the mechanical strength of the screws > 8.8 according to ISO 898-1**
> 2,8 and ≤ 3,6	0,8	1,3
> 3,6 and ≤ 4,2	1,9	3,0
> 4,2 and ≤ 5,3	3,7	6,0
> 5,3 and ≤ 6,3	6,5	10,0
M8	15,0	25,0
M10	31,0	50,0

29 Clearances, creepage distances and solid insulation

This clause of Part 1 is applicable.

30 Resistance to heat and fire

This clause of Part 1 is applicable except as follows.

30.2 *Addition:*

30.2.3 is applicable.

31 Resistance to rusting

This clause of Part 1 is applicable.

32 Radiation, toxicity and similar hazards

This clause of Part 1 is applicable except as follows.

32.1 *Addition:*

Appliances shall be so constructed and enclosed that there is adequate protection against access to the **microwave enclosure**, and that any microwave energy emanating from it is non-hazardous.

Microwave leakage is determined by measuring the microwave flux density using an instrument capable to measure microwave flux densities from about 5 W/m^2 to at least 250 W/m^2, that reaches 90 % of its steady reading in 2 s to 3 s when subjected to a stepped input signal. To simplify the use of the instrument, a non-interfering spacer is mounted on the sensor probe, providing a required minimum distance of 50 mm between the sensor and any external object.

*The microwave leakage reading with the sensor at any point 50 mm or more from the external surface of the appliance or any **microwave barrier** shall not exceed 50 W/m^2, averaged over the most onerous 20 s interval. The instrument reading shall not exceed 250 W/m^2.*

NOTE Microwave leakage can vary with power pulsing (including brief operation under the test conditions in 22.107, 19.101 and 101.1.1) and **load** variations. Depending on the actual time constant of the instrument, readings are then taken every 2 s or 3 s.

*Compliance for appliances with **large area contacting applicator** is checked by the test in 32.101 under the conditions in 101.1.1. Compliance for appliances with **insertion applicator** is checked by the tests in 32.101 under the conditions in 101.1.3. Compliance for appliances with **small area contacting applicator** is checked by the tests in 32.101 under the conditions in 101.1.2.*

32.101 *In a first test series, all **microwave barriers** are in place and the spacer tip is moved over and away from the external surface of the appliance and **microwave barrier** to locate the highest microwave leakage, particular attention being given to the openings and the microwave **barriers**. The region inside a geometric opening into the **microwave enclosure** or **microwave barrier** is not regarded as accessible.*

*A second test series is then carried out at the openings of appliances with **large area contacting applicators** and **insertion applicators** as specified in Table 102, with removed **microwave barriers**, and any interlock to any of them being defeated. A metal rod with 2,5 mm diameter and 100 mm length (test probe C of IEC 61032) is used with the instrument sensor spacer for this test, as shown in Figure 102. During the operation, the free rod end is moved in any position near but not inside the surface of the geometric openings specified in Table 102. The position of the sensor is not to be any closer than 50 mm to any part of the external surface of the appliance, and to the surface of the geometric opening of the **microwave enclosure**.*

Two additional sensor spacer tip and rod locations are to be used: as shown in Figure 102 but with the spacer tip and its rod end now placed at the opening; and with the rod centre mounted at the sensor spacer tip and a rod end at the opening.

*If the leakage reading is less than 50 W/m^2, the reference surface for 101.6 is at the surface of the geometric opening of the **microwave enclosure** without **microwave barrier**. If the leakage reading exceeds 50 W/m^2 under these conditions, the locations of the sensor (not spacer tip) further away from the **microwave enclosure** where this value is measured are recorded. The position of the reference surface away from the surface of the appliance is then determined as 50 mm straight inwards from this sensor position and towards the surface of the appliance.*

NOTE The optimum length of the wire is different for operating microwave frequencies other than 2 450 MHz.

32.102 *All **microwave guards** and **microwave barriers** are in place and the spacer tip is moved over and away from the external surface of the appliance and any **microwave guard** or **microwave barrier** to locate the highest microwave leakage, particular attention being given to the openings. The region inside a geometric opening into the **microwave enclosure** or **microwave guard** or **microwave barrier** is not regarded as accessible.*

32.103 *With all **microwave guards** of **small area contacting applicators** in place, two additional sensor spacer tip and rod locations are to be used: as shown in Figure 102 but with the spacer tip and its rod end now placed at the opening between the **microwave guard** and the **load**; and with the rod centre mounted at the sensor spacer tip and a rod end at the opening.*

101 Protection against accessibility to microwave-containing regions

101.1 The microwave leakage-preventing action of mating parts of **applicators** and the **load** shall provide adequate protection against microwave leakage.

NOTE Means of leakage prevention can be capacitive seals, quarterwave chokes (acting by impedance transformation), mode chokes (acting by field pattern mismatching) and microwave energy absorbers.

Compliance is checked by inspection and the applicable tests in 101.1.1 to 101.1.2.

101.1.1 **Large area contacting applicators** are operated under the conditions in 3.1.9 and additionally with a second **load** consisting of a compact assembly of softwood planks with a moisture content of 15 % to 20 %. The assembly should extend at least 120 mm outwards from the space of the **applicator** and be at least 200 mm high.

101.1.2 **Small area contacting applicators** are operated under the conditions in 3.1.9.

101.1.3 Appliances with **insertion applicator** for moisture removal by insertion into holes in floor, wall or ceiling structures are operated under the conditions in 3.1.9.

101.1.4 The dimensions of **viewing openings** and permanently open means of access for ventilation, liquid evacuation or similar shall be less than 20 mm × 50 mm.

Compliance is checked by inspection.

101.2 The free height between a **large area contacting applicator** and a flat **load** shall be less than 20 mm.

Compliance is checked by inspection of the appliance and its instruction sheet.

101.3 If the manufacturer's specifications allow use of the appliance with non-flat **loads**, the test in 22.107 is repeated with the most onerous **load** geometry allowed by that specification.

Compliance is checked by inspection of the appliance and its instruction sheet.

101.4 The free accessible distance between the external housing or any **microwave guard** of an appliance with **insertion applicator** and the **load** shall be less than 20 mm.

Compliance is checked by inspection.

101.5 The free accessible distance between the **microwave guard** of a **small area contacting applicator** and a flat **load** shall be less than 20 mm.

Compliance is checked by inspection.

101.6 There shall be **microwave barriers** if there are accessible openings into the **microwave enclosure**.

There shall be **microwave barriers** between a **large area contacting applicator** and the **load**, and at an **insertion applicator** and its **load**.

Microwave barriers shall not be constructed of metal or microwave-absorbing material in such a way that they can guide or absorb microwaves and their accessible openings shall not be larger than the openings that they protect.

Microwave barriers shall be removable only with the aid of a **tool**.

NOTE 1 The function of the **microwave barrier** is to act solely as a mechanical barrier.

Microwave barriers shall withstand the tests in 21.101 and 21.102. Furthermore, it shall not be possible to insert the test probe B of IEC 61032 through any holes in **microwave barriers**, with exception of the accessible end opening.

Compliance is checked by inspection, the specified tests and the tests in Table 102.

*The dimensional and microwave leakage measurement requirements on **microwave barriers** in relation to the dimension and type of opening are given in Table 102. The barrier length is calculated from the reference surface as obtained by the applicable measurements in 32.101 but shall extend all the way to the opening of the **microwave enclosure**.*

Table 102 – Specifications for microwave barriers

Opening dimension	Allowed use	Required barrier extent	Microwave leakage measurement	Remarks
Up to 20 mm	Only between **contacting applicator** and the **load**	80 mm from reference surface	With and without 100 mm rod. 20 s time of integration	
20 mm × 50 mm to Ø 12 mm	Any purpose	80 mm from reference surface	With and without 100 mm rod. 20 s time of integration	
Ø 12 mm to Ø 3 mm	Any purpose	None	Only without rod. 20 s time of integration	Ø 12 mm holes in **applicator** walls will need protection against leakage
< Ø 3 mm and narrow slots in metal surfaces	Any purpose	None	Only without rod. The leakage measurement integration time is that of the instrument (2 s to 3 s) for narrow slots	

Compliance is checked by inspection and the applicable tests in 32.101 and 32.102.

NOTE 2 A method for testing the microwave properties of the **microwave barrier** is by a heating test of a part of it in a laboratory microwave oven, for about 30 s. Appropriate material will not become hot and in particular there will be no hot spots.

NOTE 3 At 2 450 MHz, narrow slots in an **applicator** can radiate significant microwave energy if their length approaches a half wavelength. A contacting part of the body can then be subjected to a very local but high power absorption even when there is a small leakage measured 50 mm away. There will be no leakage from slots less than 3 mm wide in TE_{10} waveguides, along a wide side longitudinal centreline or in the short side in the plane of a transverse cross section.

101.7 Microwave guards shall withstand the tests in 21.101 and 21.102. Furthermore, it shall not be possible to insert the test probe B of IEC 61032 through any holes in it, with exception of the opening according to 101.6 at the **load**.

*Compliance is checked by inspection and the specified tests. After these tests, the **microwave guards** shall comply with 32.102.*

Dimensions in millimetres

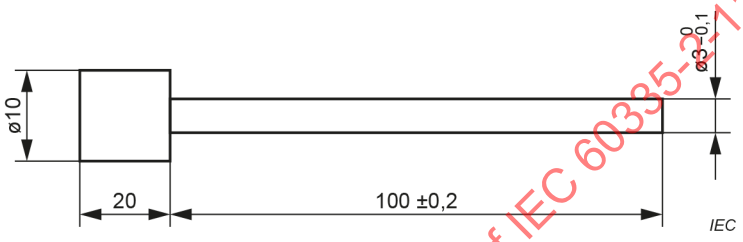
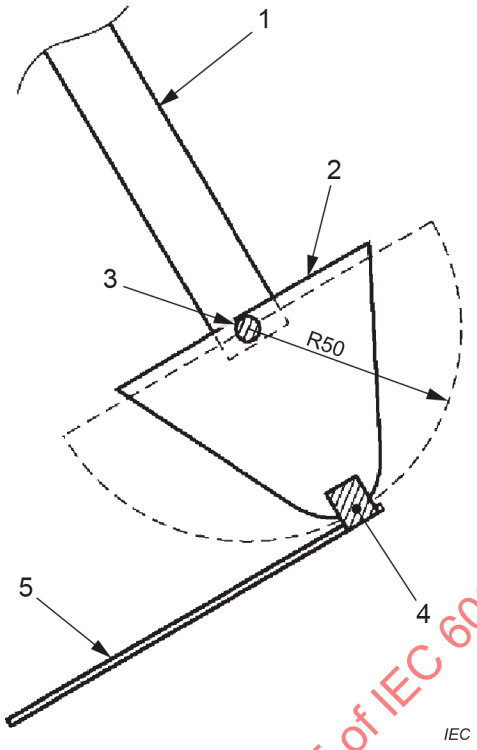


Figure 101 – Test rod for interlock concealment

Dimensions in millimetres



Key

1 probe handle

2 probe spacer

3 field sensor

4 tape

5 metal rod

NOTE 1 A hollow metal tube can be used instead of a solid rod. Its outer dimensions are $L = 100^{\pm 1}$ mm, $\varnothing = 2{,}5^{\pm 0{,}15}$ mm. As material, non-magnetic metal like aluminium or brass can be used.

NOTE 2 The rod can be fixed to the probe spacer with a thin **microwave transparent** tape so that the field sensor is located approximately 90° out from the end of the rod. Only when there is not enough space in the vicinity of the access opening the sensor can be more aligned with the rod. The minimum distance from the rod – and any other part of the appliance, including the surface of the access opening – to the field sensor is 50 mm.

NOTE 3 Since the rod acts as an antenna, contact between the rod and metal part can cause spurious readings. Thus, maintaining a minimum distance can be maintained.

Figure 102 – Arrangement for measurement of microwave leakage

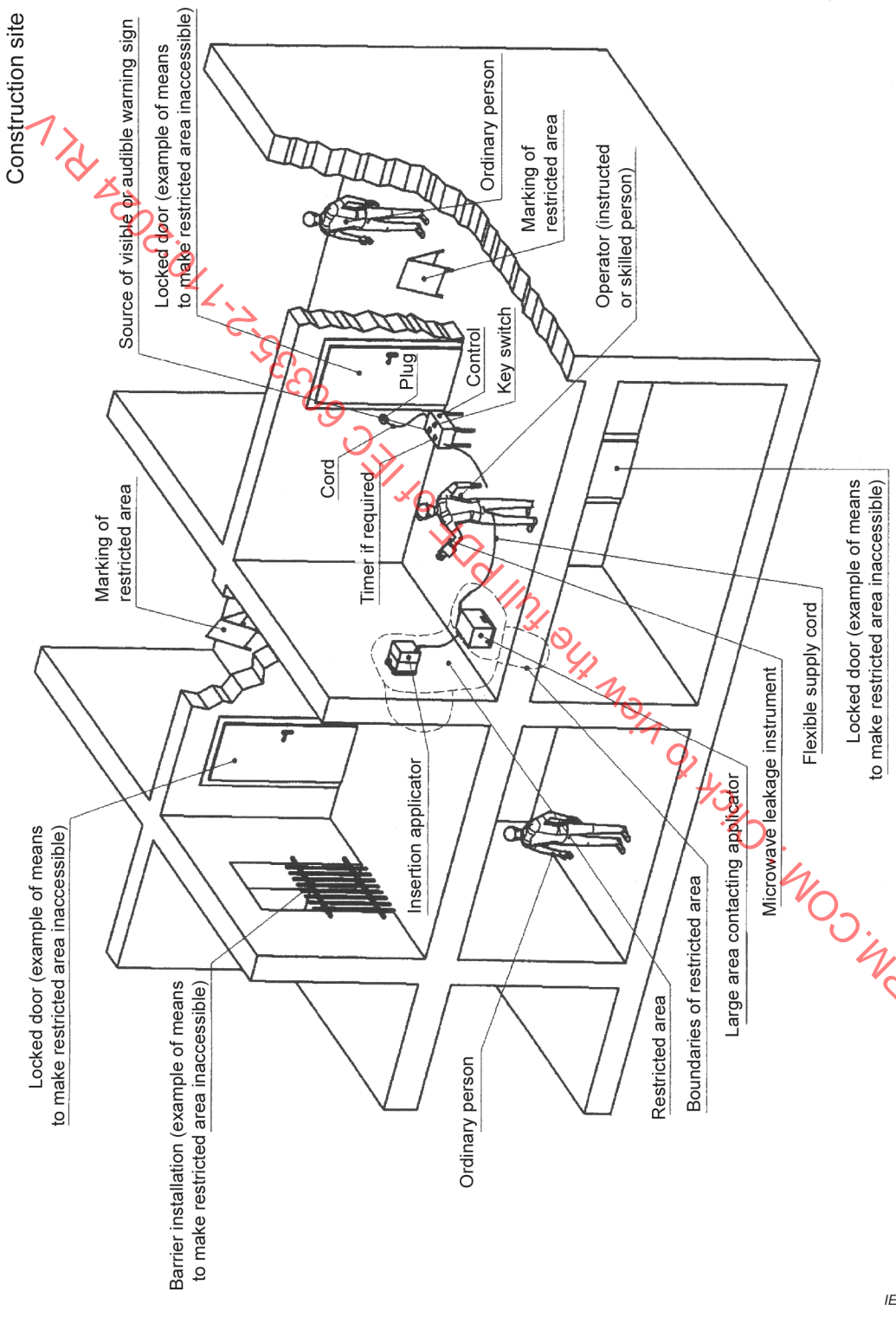


Figure 103 – Construction site, overview of different applicator types and their use

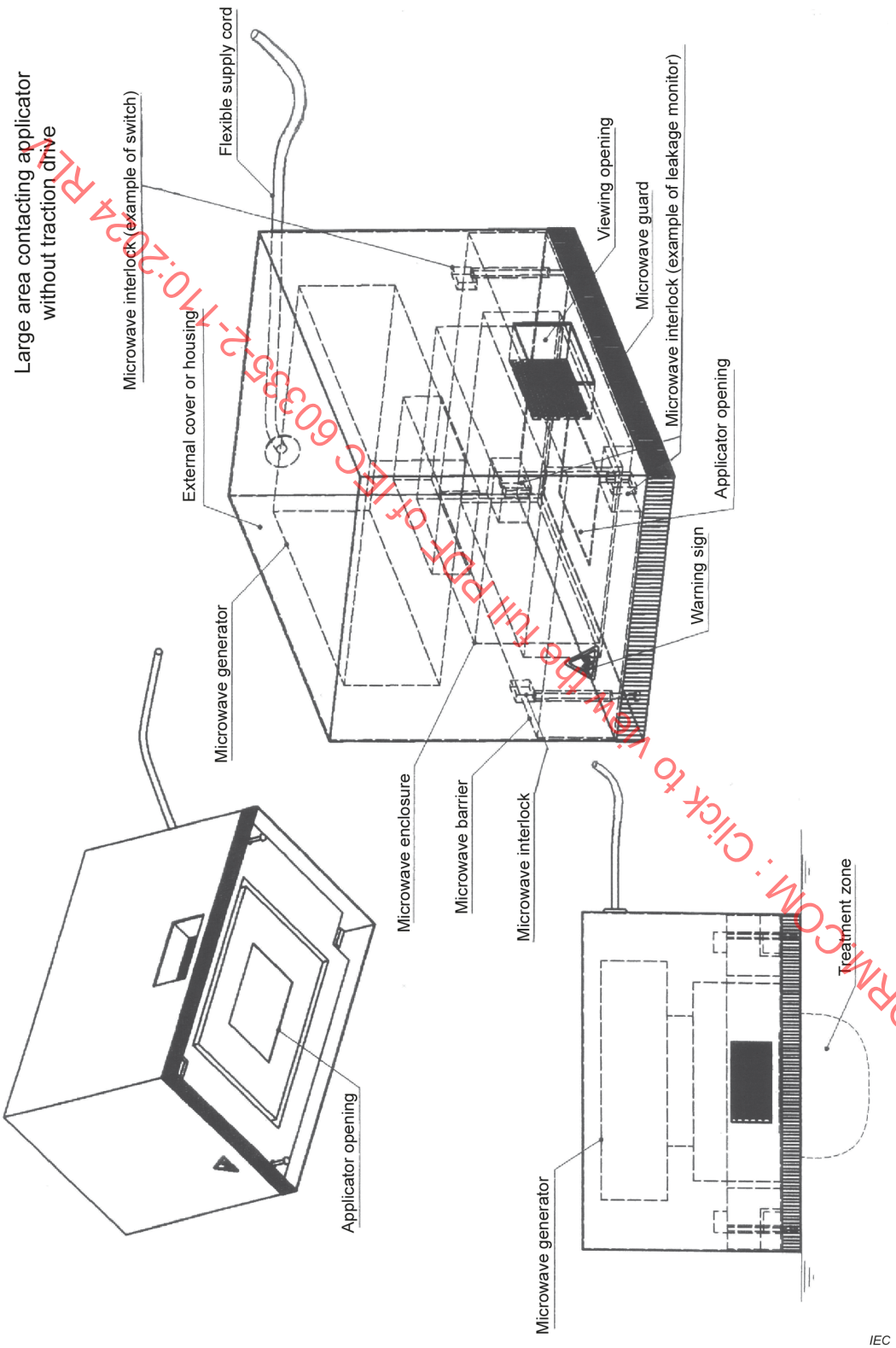


Figure 104 – Large area contacting applicator without traction drive

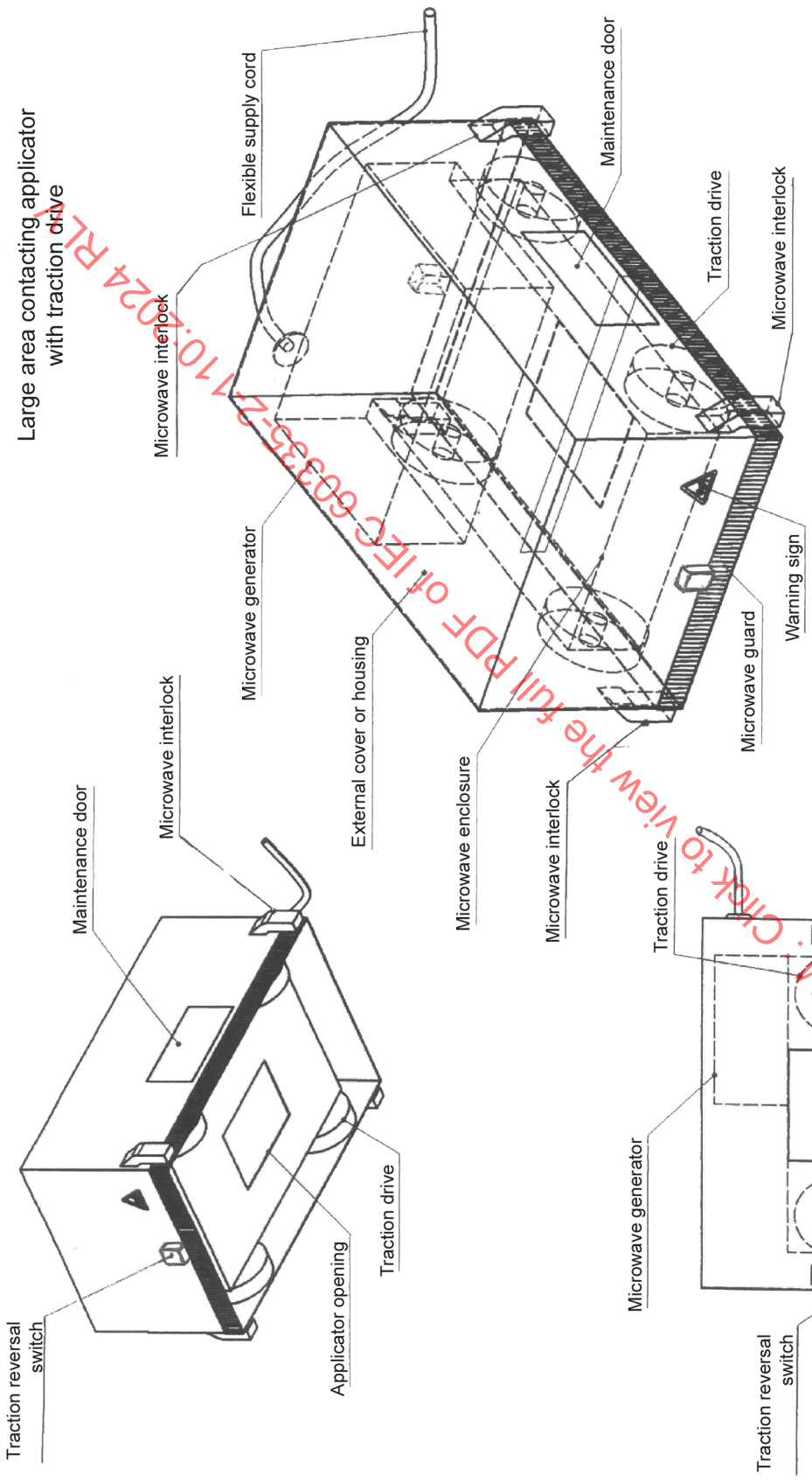


Figure 105 – Large area contacting applicator with traction drive

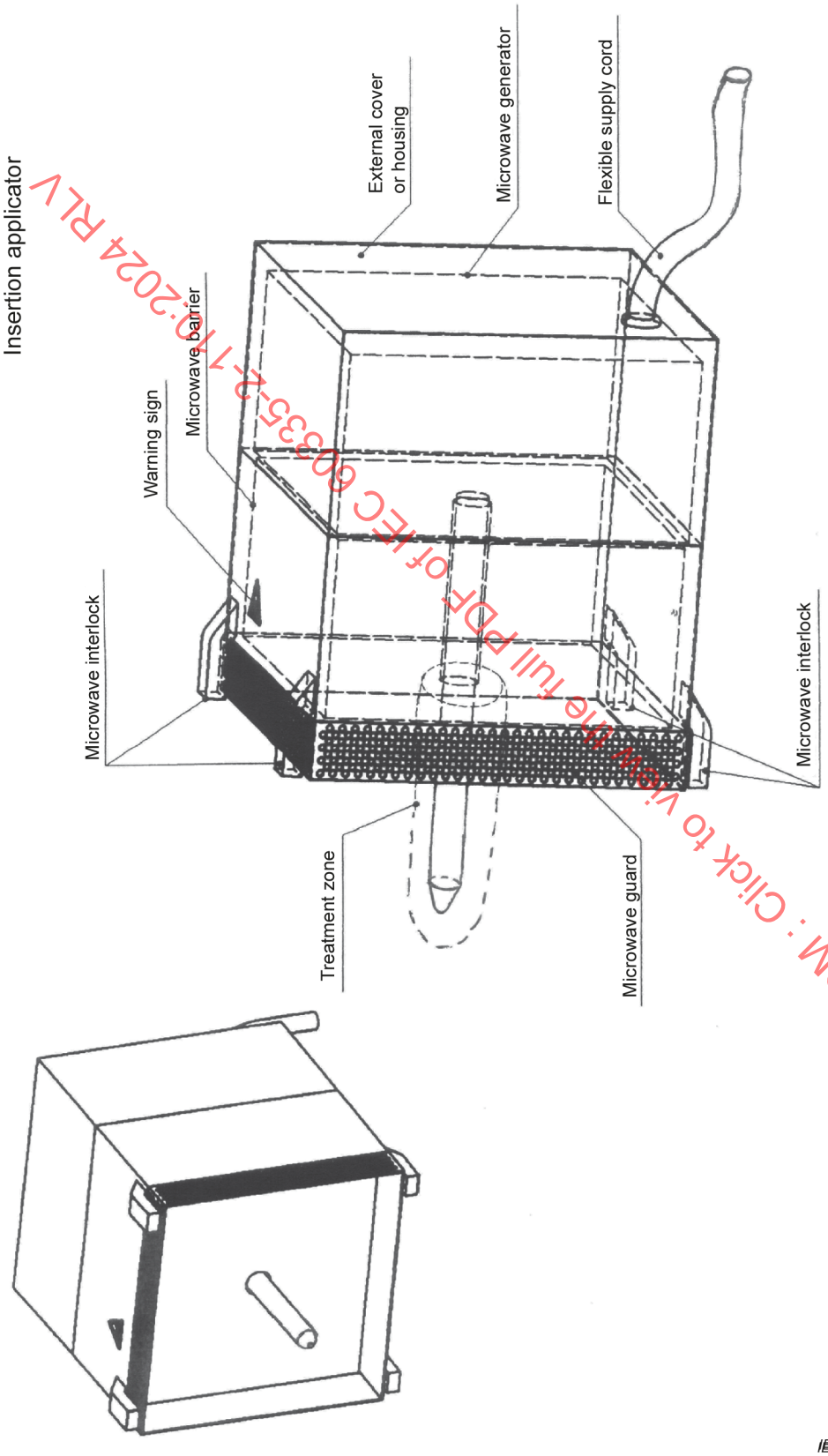
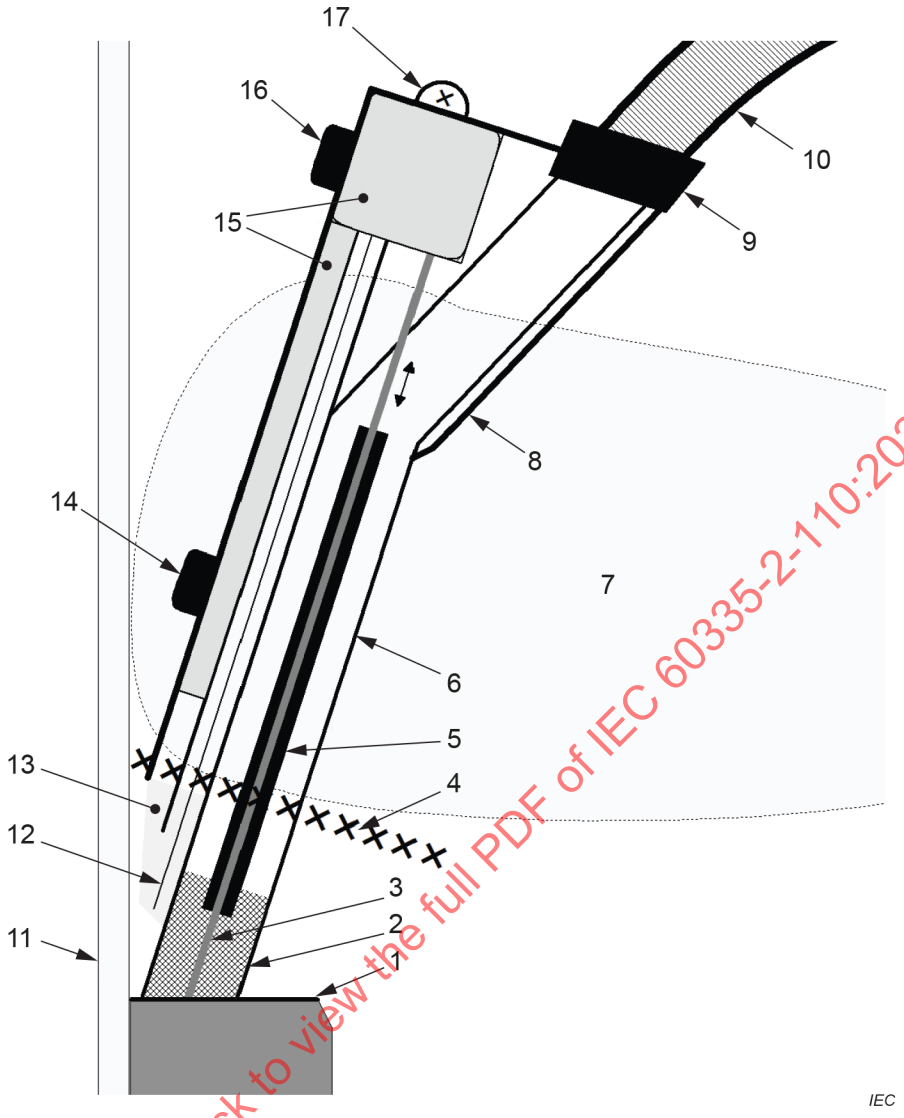


Figure 106 – Insertion applicator



Key

1 **load** (e.g. window frame with paint to be removed)
2 **small area contacting applicator** in metal housing (non-radiating into free space)
3 spring-loaded axial **microwave transparent** rod for **load** presence sensing, activating a **microwave interlock**
4 asymmetric guard or **microwave guard**
5 centre conductor of coaxial line (its continuation upwards to the right not shown)
6 metallic tube, also outer conductor of coaxial line
7 area of the gripping position of the operator's hand when appliance is in use
8 outer enclosure, also containing **control** wiring
9 feedthrough for coaxial line and **control** wiring
10 grounded flexible cable containing coaxial line and **control** wiring
11 glass window above the window frame
12 microwave leakage sensor
13 **microwave transparent** cover (made of e.g. plastic) for microwave leakage sensor
14 **operation switch**
15 space for electrical components and wiring
16 **start switch**
17 operation lamp (orange or yellow)

Figure 107 – Small area contacting applicator

Annexes

The annexes of Part 1 are applicable except as follows.

Annex AA
(informative)

Rationales for the microwave barrier and associated leakage tests

AA.1 Standard measurement of microwave oven leakage

There are several commercial instruments on the market. Those that perform sufficiently well for the purpose have a small, reasonably isotropic (omnidirectional) sensor at the end of a plastic rod. The sensor reacts to the electric field only. There is also a non-disturbing sensor spacer which is used to determine a 50 mm minimum distance between the sensor and any part of the appliance as specified in the standard. Testing of instruments include calibration in the far field (the inaccuracy is allowed to be about ± 20 %), and one or two tests intended to show that the sensor is "electrically small" so that it does not itself cause interference (standing waves) to objects nearby.

The scale on microwave leakage instruments is not in the same units as what is actually measured (V/m) but instead in W/m^2 (or mW/cm^2). The conversion is correct only in the free space plane wave case, where the wave impedance is 377 Ω and there is unidirectional propagation. Since a standing wave is the sum of two waves propagating in different directions, and the probe is not direction-sensitive, the field impedance then becomes smaller or larger than 377 Ω, so that the instrument reading becomes erroneous. Erroneous readings are also obtained in strongly curved near fields and with the probe in a waveguide or similar where there is a single or multiple mode (having a different impedance).

The minimum 50 mm distance between the instrument sensor and any accessible part of the appliance was specified more than 40 years ago when the first microwave oven leakage standard was created. The major reasons were that it was found desirable to use the same type of instruments which were used for far-field exposure measurements, and that it was concluded that an electric field sensor instrument would not indicate a proper value for determining the outgoing power flux density if the probe was located

a) where the field curvature was very significant (in comparison with the wavelength),

b) in the presence of any standing waves near the sensor.

A reasonable compromise with the need to measure emission (i.e. in the source region, so that the "leaking spot" could be found) was found to be 50 mm for the 2 450 MHz ISM band. Even if it was noted in the instrument literature at the time that the same 50 mm distance would be less appropriate for the lower ISM band at 915 MHz, the matter was not considered so problematic that the specification was modified.

The historical reason for the choice of the maximum allowed level of 50 W/m^2 (= 5 mW/cm^2) was a result of an existing regulation on free space power flux density of up to 100 W/m^2 being acceptable in commercial and industrial environments, plus considerations of a possibility of two or more microwave ovens being located close to each other. Later, when household microwave ovens came on the market, the nature of door leakage was found to typically be from only some few leaking spots, so that the power flux density decreased almost quadratic with the distance away from these. There was no reason why the user would remain very near the closed door of an operating oven, and widely publicised investigations showed that the actual exposure of any part of the human body became very low, particularly in consideration of a reasonable averaging time of 5 min to 10 min for hazard assessment. As a result, the 50 W/m^2 limit was applied also to household microwave ovens.

In the beginning of the 1970's, the US authorities responsible for radiation safety found some quality problems with some microwave oven models and introduced a 10 W/m^2 "factory limit" for new unused ovens, in order to dampen any public concerns. Only one or two other countries followed.

In the meantime, IEC 60335-2-25, the safety standard for microwave oven for household and similar use was successively developed and the value 50 W/m^2 became the worldwide limit after all tests. However, in empty operation and after a potentially destructive door test, 100 W/m^2 was instead required. The rationales for the higher value under no-load conditions were reported difficulties by some manufacturers, and the conclusion that no-load operation would typically be even more short-term and an also uncommon fault condition.

In the 1980's, leakage measurements at covers for lamp replacement were dealt with by the experts maintaining IEC 60335-2-25. The hole array in the cavity wall, at the lamp, can of course leak microwaves. The size of the cover can be such that the 50 mm distance to the nearest appliance part can be maintained also with the sensor almost inside the external housing from which the cover has been removed. A case had been reported where the instrument reading was quite high in this condition, but there was a very low reading with the whole housing removed. The reason for the high reading was that a standing wave inside the housing had been created. There was an electric field but no real leakage since the standing wave is the sum of an outwards- and inwards-going wave and can have no net power flux. In addition, if a finger would be put into the opening, the standing wave would disappear and only the real leakage becomes the possible hazard. As a consequence, a statement was added to the standard to the effect that the instrument sensor should not be closer to the opening plane than 50 mm, i.e. the region inside the cover should not be considered accessible with regard to the leakage measurement. The same principle is adhered to in this standard, but the actual leakage situation is now really assessed, by the extended test in 32.1.

AA.2 Microwave hazards – the basic restriction

Microwave exposure is considered to be potentially hazardous if the heating of parts of the human body exceeds certain values. These are specified as SAR values (specific absorption rate) and are expressed in W/kg tissue. The lowest SAR value of whole-body exposure where there can be some risks has been found to be 4 W/kg. A safety factor of 10 is subsequently applied for **instructed persons** and a further safety factor of 5 for **ordinary persons**, resulting in the basic restriction of 0,4 and 0,08 W/kg in the two cases. Local, non-hazardous exposure limited to the head and trunk can be up to 10 W/kg and 2 W/kg, respectively. Twice this (20 W/kg and 4 W/kg) are considered non-hazardous locally in the extremities (including hands and fingers). The general microwave standards specify integration over any 10 g body mass, and the time integration is over 6 min.

AA.3 Microwave hazard evaluation – the free space exposure method

For all practical exposure situations (except from communication devices such as mobile phones for which a total source maximum power concept can apply), two simplified verification methods are used in industry and for protection of microwave workers and the general public: a maximum allowed far-field power flux density far away from the source, and an emission standard for appliances such as microwave ovens.

The issue is now if the relaxation of SAR values for parts of the body, in combination with the integration volume, are compatible with the free space exposure method.

When parts of the human body having a small radius of curvature are heated, diffraction, resonant and other focussing or amplification phenomena can occur. In the case of 2 450 MHz, the internal wavelengths in tissues as well as the penetration depth limitation result in only fingers being of major interest. In principle, also bent knuckles and elbows could create focussing effects, but fingers are definitely much more problematic with regard to the effects discussed here. It is not assumed that other protruding parts of the body such as the nose, ears or penis are brought very close to microwave leakage sources in commercial or household heating equipment.

The following modelling results indicate the degree of compatibility between the basic restriction and the free space exposure method:

Numerical modelling using commercially available electromagnetic software was used. A finger with 13 mm diameter and typical dielectric data (homogeneous, with $\varepsilon^* = 40 - j10$, where the loss factor (10) is lowered in consideration of bone and tendons) was exposed to 10 W/m^2 in free space. The strongest absorption occurred for TM_Z polarisation (i.e. with the impinging electric field parallel to the finger axis) and the mode in the finger then becomes of the TM_{Z1} type, having two opposite axial zones of maximum heating intensity. The maximum power intensity becomes 5 W/dm^3 and the average over the worst 10 cm^3 becomes about 1,8 W/dm^3.

If the finger would be exposed to a plane wave with a power flux density of 50 W/m^2 – that which is allowed from microwave ovens, etc. – the maximum value would become 25 W/dm^3 and the 10 cm^3 integrated value would become 9 W/dm^3.

The conclusions are that:

- The **ordinary person** basic restriction is exceeded. However, the types of appliances dealt with in this standard are not operated by **ordinary persons**.
- The **instructed person** basic restriction is about the same as the actual SAR value. However, the actual situation with **large area contacting applicators** as well as with **insertion applicators** is that the operator is never close to the **applicator** opening or rod antenna. A negative factor is, however, that opening regions of these **applicators** are larger than spots of an oven door as a leakage source, so that the region with a high microwave energy density can extend further out than from an oven door. Hence, the construction of the **applicators** and barriers as well as the measurement method shall ensure that SAR values of 20 W/kg in the human extremities are not exceeded.

AA.4 Microwave hazards from open applicators

The actually absorbed microwave power in a part of the human body is always very dependent on the field configuration, and the field configuration at the body part is also strongly modified by the part itself. This means that even knowledge about the true power flux density or the electric field intensity cannot be used to assess the actual microwave absorption rate and it becomes necessary to establish a more complete scenario before any calculations of the absorption can be made. Hence, the leakage intensity measured as a quasi-plane free space wave at 50 mm or more away from the source will now not alone determine the level of hazard. The actual hazard also depends on:

- any possibility of access into a region where there is microwave energy,
- the size of the opening, which can determine the type of field characteristics, or allow several kinds of microwave field characteristics,
- any objects, including a **load** to be heated or a part of the body at the opening, which can also determine the type of field characteristics.

The access situation is of course crucial and shall be standardised in some ways so that reasonably simple and objective procedures and requirements can be established. Since only the arm, hand and finger (and leg, foot and toes) are considered to be the parts of the body which can get in contact with or close to **applicator** openings of these appliances, two important issues can be directly quantified:

a) all geometric factors (by test probe B, etc.), and

b) as addressed above, these parts of the body are less sensitive than for example the head.

An important principle is that a "hazard boundary" (called reference surface in this standard) is defined somewhere in the vicinity of the physical opening surface and that a leakage instrument reading of 50 W/m^2 is to apply for the tests. This means that what remains is to construct tests which will ensure, with reasonable certainty, that actual power densities (in W/m^3, or SAR values in W/kg) in human extremities "contacting" the reference surface will not exceed those caused by a "normal" leakage source such as a microwave oven door region giving a power flux density reading of 50 W/m^2 at 50 mm distance from any part of the appliance.

The field configuration then becomes the issue, i.e. how to obtain realistic measurement results with the same type of instruments as are used for microwave ovens with a door. Clearly, there is a need for simplification and standardisation using some typical scenarios. The most important matter is then to consider cases where access would be more severe than in the normal door leakage case. These "onerous" cases are as follows.

- The field configuration is such that there is a very high intensity in a region, and the intensity diminishes very quickly with increasing distance, so that no reading can be obtained with the sensor 50 mm away from the **applicator** opening – but there is obviously a quite hazardous microwave energy density at the opening. Structures creating non-radiating near fields or strongly evanescent modes have this effect. **Small area contacting applicators** are excellent examples of this – they do in fact need to have such characteristics for compliance with this standard and there shall of course be adequate protection of the operator against access to the **applicator** opening.
- The field configuration is such that a microwave power flux is bound to a dielectric object. The **loads** being treated with **large area contacting applicators** are the most typical example, and a bound surface wave can then exist, and "transport" microwave power away from the opening. The "best" condition for this phenomenon occurs with **loads** having a very high water content (a very high dielectric constant ε'). There can then be no leakage instrument reading with the sensor 50 mm up, but with the metal rod in Figure 102.

In this standard, a method of leakage extraction and non-shielding **microwave barriers** is used. One end of the metal rod can act as a receiving antenna and since the end can be located very close to parts of the **applicator** and **load**, it will also pick up near fields, evanescent modes and surface waves when suitably oriented. A "spatial averaging" of the externally available microwave energy also results, since the instrument sensor is still not closer than 50 mm to any other object.

AA.5 Time averaging

There are only two time integration specifications in the existing national standards by radiation protection agencies:

a) 6 min for whole-body exposure (probably including fingers), and

b) criteria for duty cycles in cases of very short pulses such as from radar transmitters. Additionally, in some national legislation on non-ionising radiation, there is a ceiling value of exposure; a ceiling value of e.g. 250 W/m^2 and a 10 W/m^2 average can be interpreted as maximum 300/25 = 12 s, isolated strong exposure being allowed during any 6 min interval, with no exposure during the remaining 5 min 48 s of the interval.

The 6 min integration time is quite compatible with typical cases of irradiation of parts of the body having a radius of curvature larger than about one free space wavelength of 2 450 MHz microwaves. In such cases, essentially a plane damped wave propagation can be assumed, as well as a depth of 30 mm to 40 mm in the tissue over which equilibration by heat conduction takes place. Using the heat conductivity data and the Fourier heat conduction equation then results in a time constant (i.e. about 63 % of the stationary conditions have occurred) of about 5 min. A useful comparison is with boiling of an egg in 100 °C water: it takes about 5 min for the centre to reach a temperature of about 65 °C.

The most onerous heating pattern in a diameter 13 mm finger under plane wave 2 450 MHz irradiation is uneven, with about 5 mm distance between the hot and cold areas. It can be shown that the overall microwave coupling is strongest for about a diameter 16 mm finger. The corresponding distance between hot and cold areas then becomes 7 mm or less.

The Fourier heat conduction equation is spatially quadratic. Using the boiling of a diameter 40 mm egg in 5 min having distance between the cold and hot regions is 20 mm as a basis, a 7 mm distance would be similarly equilibrated in $(7/20)^2$ of 5 × 60 s, i.e. about 35 s integration time is adequate.

There is, however, another factor to also consider: even a very localised heating rate should not be so high that there will be any risk of pain or injury during the time of integration. A suitable acceptable local temperature rise can be set to 5 K, in consideration of both that the skin area with heat-sensing nerves will be heated at least by conduction and that such a temperature rise under short term conditions will not cause any injury in the fingers. A normal person will feel and react to a temperature increase of the same order of less – about 3 K – within some very few seconds.

A homogeneous SAR value of 20 W/kg (the basic restriction for **instructed person** fingers) will result in a temperature rise rate of about 0,5 K/min.

Now suppose that only e.g. the tip of a finger absorbs all power and the remainder of the 10 g absorbs no power. Such scenarios shall actually be considered for **small area contacting applicators** dealt with in this standard and of course occurs e.g. with the finger if there is access to the near field. The volume of that part of the tip that absorbs microwaves is now set to 0,5 cm^3 (which is the volume of a hemisphere with diameter 12 mm). Using this in relation to the 10 cm^3 of the basic restriction, one obtains 20 times faster "allowed" temperature rise rate of 10 K/min. This will also mean that the person will feel the heating of the finger within 20 s. Since the equilibration by heat conduction has about the same time constant as above, one again arrives at about 30 s suitable integration time.

AA.6 Conclusions and modifications of differences to the existing standards for microwave ovens with a cavity door

The 6 min time of integration specified in many existing standards is inadequate for the purposes of this standard. A more realistic value should be 30 s. However, additional requirements on protection against accessibility to microwave-containing regions are also needed – and are contained in Clause 101 of this standard.

The existing emission standard for microwave ovens specifies an integration time of about 2 s for the measurement. This is for historical and practical rather than safety reasons. A typical household microwave oven has either a ceiling stirrer or a turntable, and with the specified circularly cylindrical test **load**, the leakage variation periodicity will be comparable to or less than the specified integration time. Measurements are then correct and made easily and quickly with the present standards for microwave ovens with a cavity door for user access.

Since the appliances considered in this standard behave quite differently, there is no reason to introduce limitations on construction which have no relevance to safety considerations. The same 20 s time of integration for leakage measurements as in IEC 60335-2-90 shall therefore be applied. This is somewhat shorter than 30 s, but allows faster measurements and easier integration. The most onerous 20 s interval is to be chosen, and the instrument integration time of 2 s to 3 s shall be maintained.

In addition, the same maximum measured (integrated, ceiling) value of 250 W/m^2 as in IEC 60335-2-90 for microwave tunnel ovens, consistent with the instrument integration time of 2 s to 3 s is introduced, to simplify instrument specifications and handling as well as the numerical integration in cases of highly variable leakage. Such strong variability can occur for example in appliances with a protective device consisting of a built-in leakage monitor coupled to a cut-out.

Bibliography

The bibliography of Part 1 is applicable except as follows.

Addition:

IEC 60335-2-25, *Household and similar electrical appliances – Safety – Part 2-25: Particular requirements for microwave ovens, including combination microwave ovens*

IEC 60519-6, *Safety in installations for electroheating and electromagnetic processing – Part 6: Particular requirements for high frequency dielectric and microwave heating and processing equipment*

IEC 60601-1, *Medical electrical equipment – Part 1: General requirements for basic safety and essential performance*

IEC 61010 (all parts), *Safety requirements for electrical equipment for measurement, control, and laboratory use*

IEC 60989:1991 [1], *Separating transformers, autotransformers, variable transformers and reactors*

[1] Withdrawn.

SOMMAIRE

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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APPAREILS ÉLECTRODOMESTIQUES ET ANALOGUES – SÉCURITÉ –

Partie 2-110: Exigences particulières pour les appareils à micro-ondes à usage commercial avec applicateurs par insertion ou par contact

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L'IEC 60335-2-110 a été établie par le sous-comité 61B: Sécurité des fours à micro-ondes à usage domestique et commercial, du comité d'études 61 de l'IEC: Sécurité des appareils électrodomestiques et analogues. Il s'agit d'une Norme internationale.

Cette deuxième édition annule et remplace la première édition parue en 2013 et l'Amendement 1:2019. Cette édition constitue une révision technique.

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

– le Paragraphe 7.1 a été amélioré pour plus de clarté;
– les Paragraphes 19.11.2 et 19.103 ont été améliorés pour plus de clarté;
– l'Article 28 a été modifié afin d'ajouter des exigences pour les vis.

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

Projet	Rapport de vote
61B/688/CDV	61B/691A/RVC

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.

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*, peut être consultée 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 appareils à micro-ondes à usage commercial avec applicateurs par insertion ou par contact.

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**.

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.

IMPORTANT – Le logo "colour inside" qui se trouve sur la page de couverture de ce document indique qu'il contient des couleurs qui sont considérées comme utiles à une bonne compréhension de son contenu. Les utilisateurs devraient, par conséquent, imprimer ce document en utilisant une imprimante couleur.

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 et du SC 61B, accessibles sur le site web de l'IEC à l'adresse:
https://www.iec.ch/tc61/supportingdocuments
https://www.iec.ch/sc61b/supportingdocuments

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

La présente norme reconnaît le niveau de protection internationalement accepté contre les dangers 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 altérer le fonctionnement sûr des appareils.

Cette 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 nationales d'installation 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.

Cette 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 2-110: Exigences particulières pour les appareils à micro-ondes à usage commercial avec applicateurs par insertion ou par contact

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 appareils à micro-ondes à usage commercial dont la **tension assignée** est inférieure ou égale à 250 V pour les appareils monophasés raccordés entre un conducteur de phase et le conducteur de neutre, et à 480 V pour les autres appareils.

Dans la mesure du possible, la présente norme traite des dangers courants que présentent ces types d'appareils.

Les appareils couverts par la présente norme comportent un **applicateur** ouvert (voir l'exemple de vue d'ensemble de la Figure 103) destiné au traitement de la **charge**. Ils sont classés en trois types:

– les appareils avec **applicateur par insertion**, généralement destinés à l'élimination de l'humidité par insertion dans des trous au plancher, au mur ou au plafond (voir l'exemple représenté sur la Figure 106);
– les appareils avec **applicateur par contact de grande surface**, généralement destinés au séchage de planchers, murs ou plafonds (voir les exemples représentés à la Figure 104 et Figure 105);
– les appareils avec **applicateur par contact de petite surface**, généralement destinés au décapage de peinture et au chauffage localisé (voir l'exemple représenté sur la Figure 107).

Les appareils à micro-ondes avec **applicateur par insertion**, **applicateur par contact de grande surface** ou **applicateur par contact de petite surface** utilisent l'énergie électromagnétique sur une ou plusieurs bandes de fréquences ISM comprises entre 300 MHz et 30 GHz pour fournir de l'énergie à une **charge** externe qui est chauffée de manière à assurer le séchage, où le transport d'humidité peut conduire à la génération de forces causée par la formation de vapeur, la décomposition ou la modification chimique, la fusion ou la destruction d'organismes tels que les bactéries ou les champignons.

NOTE 101 Les bandes de fréquences ISM sont les fréquences électromagnétiques établies par l'UIT et reproduites dans la CISPR 11.

NOTE 102 Les aliments et les boissons ne constituent pas des charges au sens de la présente norme.

Les appareils avec **applicateur par insertion** et avec **applicateur par contact de grande surface** sont des **appareils mobiles**. Les appareils avec **applicateur par contact de petite surface** sont des **appareils portatifs**.

Les appareils qui utilisent une énergie non électrique relèvent du domaine d'application de la présente norme. La section à micro-ondes est considérée comme un **appareil à moteur**.

La justification de la **barrière micro-ondes** et des essais de fuite associés est décrite dans l'Annexe AA informative.

L'attention est attirée sur le fait que

– ces appareils peuvent rayonner de l'énergie micro-ondes à l'extérieur d'une **zone restreinte**, où ils sont utilisés. La présente norme prend en compte les exigences supplémentaires spécifiées par les organismes nationaux responsables de la protection contre les rayonnements non ionisants, selon lesquelles la puissance surfacique à l'extérieur de cette **zone restreinte** est limitée à une moyenne de 10 W/m^2 par période de 6 min;

– ces appareils sont exclusivement destinés à traiter la **charge** dans les **conditions de fonctionnement normal**; autrement dit, la présente norme ne s'applique pas aux appareils ou systèmes qui ont recours à la propagation de micro-ondes en espace libre;

– pour les appareils destinés à être utilisés dans des pays tropicaux, des exigences particulières peuvent être nécessaires;

– dans de nombreux pays, des exigences complémentaires sont spécifiées par les organismes nationaux de la santé publique et par les organismes nationaux responsables de la protection des travailleurs et de la protection contre les rayonnements non ionisants.

La présente norme ne s'applique pas

– aux fours à micro-ondes domestiques, y compris les fours à micro-ondes combinés (IEC 60335-2-25);

– aux fours à micro-ondes à usage commercial avec porte de cavité, aux fours à micro-ondes combinés à usage commercial avec porte de cavité et aux fours à micro-ondes combinés à usage commercial sans porte de cavité et avec moyen de transport (IEC 60335-2-90);

– aux installations de chauffage industriel à hyperfréquences (IEC 60519-6);

– aux appareils destinés à des usages médicaux (IEC 60601-1);

– aux appareils et équipements destinés à un usage en laboratoire (série IEC 61010);

– aux appareils destinés à être utilisés dans des locaux qui présentent des conditions particulières, telles que la présence d'une atmosphère corrosive ou explosive (poussière, vapeur ou gaz).

Certains des essais et spécifications cités dans la présente norme ne s'appliquent pas aux appareils qui fonctionnent à d'autres fréquences que 2 450 MHz.

2 Références normatives

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

Addition:

IEC 60335-2-90, *Appareils électrodomestiques et analogues – Sécurité – Partie 2-90: Exigences particulières pour les fours à micro-ondes à usage commercial*

ISO 898-1, *Caractéristiques mécaniques des éléments de fixation en acier au carbone et en acier allié – Partie 1: Vis, goujons et tiges filetées de classes de qualité spécifiées – Filetages à pas gros et filetages à pas fin*

ISO 3506-1, *Fixations – Caractéristiques mécaniques des fixations en acier inoxydable résistant à la corrosion – Partie 1: Vis, goujons et tiges filetées de grades et classes de qualité spécifiés*

ISO 3506-2, *Fixations – Caractéristiques mécaniques des fixations en acier inoxydable résistant à la corrosion – Partie 2: Écrous de grades et classes de qualité spécifiés*

ISO 3506-3, *Caractéristiques mécaniques des éléments de fixation en acier inoxydable résistant à la corrosion – Partie 3: Vis sans tête et éléments de fixation similaires non soumis à des contraintes de traction*

ISO 3506-4, *Caractéristiques mécaniques des éléments de fixation en acier inoxydable résistant à la corrosion – Partie 4: Vis à tôle*

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*

ISO 7010, *Symboles graphiques – Couleurs de sécurité et signaux de sécurité – Signaux de sécurité enregistrés*

3 Termes et définitions

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

3.1 Définitions relatives aux caractéristiques physiques

3.1.7

Note 101 à l'article: La **fréquence assignée** est la fréquence absorbée.

3.1.9

Modification:

Remplacer le premier alinéa par ce qui suit:

fonctionnement de l'**appareil** en mode chauffage dans les conditions suivantes:

L'**appareil** est mis en fonctionnement conformément aux instructions du fabricant pour l'**utilisation prévue**. Cependant, l'emploi d'une **charge** type pour l'**utilisation prévue** peut ne pas être réalisable, car la **charge** peut faire partie d'un bâtiment, sauf si le fabricant met à disposition de telles **charges** pertinentes et réalistes pour la réalisation des essais. Si tel n'est pas le cas, l'appareil est mis en fonctionnement dans les conditions suivantes:

La température initiale de la **charge** d'essai utilisée pour l'absorption de l'énergie micro-ondes doit être de (20 ± 5) °C.

Les réglages de puissance les plus élevés du générateur doivent être utilisés.

Les appareils avec **applicateur par insertion** destinés à l'élimination de l'humidité fonctionnent par insertion dans des trous au plancher, au mur ou au plafond, dans les conditions suivantes:

a) La **charge** d'essai se compose d'une cuve métallique remplie d'eau dont la surface supérieure ouverte dépasse les dimensions horizontales de l'appareil d'au moins 70 mm de chaque côté et dont la colonne d'eau présente une hauteur supérieure d'au moins 150 mm par rapport à la longueur de la distance d'insertion la plus longue de **l'applicateur par insertion**. En partie haute, les côtés de la cuve comportent des supports horizontaux construits dans un matériau **transparent aux micro-ondes**, avec une ouverture adaptée pour l'antenne de l'**applicateur**. Le niveau de l'eau est ajusté de telle sorte que la distance entre le boîtier de l'appareil et la **charge** d'essai soit la même que pour l'**utilisation prévue**.

Note 101 à l'article: S'il apparaît clairement qu'une adaptation satisfaisante de l'impédance micro-ondes de l'**applicateur par insertion** ne peut être obtenue que si le trou dans lequel ce dernier est inséré n'est pas rempli d'eau, une gaine ou un dispositif analogue construit dans un matériau hautement **transparent aux micro-ondes**, tel que le polytétrafluoroéthylène (PTFE), est utilisé autour de l'**applicateur par insertion.** Si une propagation axiale des ondes est constatée dans le montage d'essai et que le fabricant peut démontrer qu'un tel phénomène ne peut pas se produire dans les conditions d'utilisation réelles ou que, dans un tel cas, les dispositifs de surveillance arrêtent l'**applicateur par insertion**, un tube plastique à paroi mince d'un diamètre intérieur correspondant au diamètre maximal du trou conforme aux spécifications du fabricant peut être utilisé.

b) Les appareils avec **applicateur par contact de grande surface** destinés au séchage de planchers, murs ou plafonds sont mis en fonctionnement dans les conditions suivantes: la **charge** d'essai se compose d'une cuve métallique remplie d'eau dont la surface supérieure, ouverte, dépasse les dimensions horizontales de l'appareil d'au moins 70 mm de chaque côté et dont la colonne d'eau présente une hauteur minimale de 150 mm. Deux côtés opposés de la cuve comportent des supports horizontaux construits dans un matériau **transparent aux micro-ondes**, placés en partie haute, qui s'enfoncent à l'intérieur de l'enceinte suffisamment pour que le **dispositif de transmission** repose dessus. Le niveau de l'eau est ajusté de telle sorte que la distance entre l'**applicateur** et la **charge** d'essai soit la même que pour l'**utilisation prévue**. La fonction d'inversion du **dispositif de transmission** est soumise à l'essai dans les conditions suivantes: l'appareil est mis en fonctionnement sur une surface horizontale en contreplaqué d'une épaisseur de 20 mm, avec une zone suffisante pour permettre un mouvement de va-et-vient entre des blocs représentant des murs.

Note 102 à l'article: Si cela s'avère nécessaire à l'obtention d'un fonctionnement représentatif de l'appareil, les supports horizontaux sont étendus de manière à actionner les **verrouillages micro-ondes** mécaniques.

Les appareils avec **applicateur par contact de petite surface** destinés au décapage de peinture et au chauffage localisé sont mis en fonctionnement dans les conditions suivantes:

La **charge** d'essai se compose d'une meule ou d'un bloc à poncer en carbure de silicium fin d'une épaisseur minimale de 15 mm, et d'une longueur et d'une largeur qui dépassent celles de l'ouverture de l'**applicateur** d'au moins 30 mm; cependant, cette **charge** d'essai doit être suffisamment grande pour pouvoir être refroidie à l'air par la face inférieure sans influencer l'appareil.

3.1.101
puissance restituée assignée des micro-ondes
puissance micro-ondes restituée assignée à l'appareil par le fabricant

Note 1 à l'article: Cette puissance peut être inférieure à la **puissance micro-ondes disponible** du fait des pertes intentionnelles de puissance micro-ondes dans les absorbeurs de micro-ondes (voir la Note du 101.1) et les câbles coaxiaux qui assurent la protection du générateur de micro-ondes des **applicateurs par contact de petite surface** (voir le 22.101).

3.1.102
puissance micro-ondes disponible
puissance restituée nominale du générateur de micro-ondes lorsque la condition d'adaptation de l'impédance est vérifiée, qui est obtenue par la spécification et la mesure indiquées par le fabricant du générateur, de l'énergie électrique à l'entrée du générateur dans l'appareil au cours des 10 premières secondes de fonctionnement à la puissance maximale

Note 1 à l'article: Dans le cas des magnétrons, la puissance restituée se stabilise généralement après 3 s de mise sous tension.

3.6 Définitions relatives aux parties d'un appareil

3.6.101
applicateur
dispositif qui applique l'énergie micro-ondes à la **charge**

3.6.102
transparent aux micro-ondes
propriété d'un matériau qui réfléchit et absorbe de manière négligeable les micro-ondes

Note 1 à l'article: La permittivité relative d'un matériau **transparent aux micro-ondes** est inférieure à 7, et son facteur de pertes relatif est inférieur à 0,015.

3.6.103
applicateur par insertion
applicateur destiné à être inséré dans la **charge**, où la totalité de la **puissance micro-ondes disponible** est destinée à être absorbée

3.6.104
applicateur par contact de grande surface
applicateur équipé d'une enceinte métallique, qui possède au moins une ouverture géométrique non métallique à travers laquelle l'énergie micro-ondes est appliquée à une **charge** externe située près de l'**applicateur**, où la totalité de la **puissance micro-ondes disponible** est destinée à être absorbée

3.6.105
applicateur par contact de petite surface
applicateur équipé d'une enceinte métallique, qui possède au moins une ouverture géométrique non métallique ou un dispositif adéquat à travers lequel l'énergie micro-ondes est appliquée à une **charge** externe située très près de l'**applicateur**, où la totalité de la **puissance micro-ondes assignée** est destinée à être absorbée

3.6.106
dispositif de transmission
dispositif ou système utilisé pour accomplir le déplacement d'un appareil avec **applicateur par contact de grande surface** sur un plancher

3.6.107
enceinte micro-ondes
dispositif global destiné à confiner l'énergie micro-ondes

Note 1 à l'article: Les barrières montées à l'extérieur de **l'enceinte micro-ondes** ne sont pas considérées comme faisant partie de cette dernière.

3.6.108
barrière micro-ondes
élément **transparent aux micro-ondes** de l'appareil à micro-ondes, qui est monté à l'extérieur de l'**enceinte micro-ondes** afin de limiter l'accès à cette dernière et qui ne peut être enlevé qu'avec l'aide d'**outils**

Note 1 à l'article: Une **barrière micro-ondes** peut être montée entre l'**enceinte micro-ondes** et le couvercle extérieur de l'appareil.

Note 2 à l'article: Les dispositifs, tels qu'un réseau de chaînes métalliques ou des plaques métalliques à charnières en périphérie de l'ouverture d'un **applicateur** destinés à réduire les fuites micro-ondes, ne sont pas considérés comme des **barrières micro-ondes**.

Note 3 à l'article: Les **barrières micro-ondes** ne peuvent ni comporter de charnière, ni se plier.

3.6.109
protecteur micro-ondes
élément de construction de l'appareil qui est monté à l'extérieur de l'**enceinte micro-ondes** afin de réduire les fuites micro-ondes par protection et/ou absorption et qui ne peut être enlevé qu'avec l'aide d'**outils**

Note 1 à l'article: Les **protecteurs micro-ondes** peuvent se déplacer ou s'ouvrir lorsque l'**applicateur** est mis en contact avec la **charge**.

Note 2 à l'article: Les dispositifs, tels qu'un réseau de chaînes métalliques ou des plaques métalliques à charnières en périphérie de l'ouverture d'un **applicateur** destinés à réduire les fuites micro-ondes, sont considérés comme des **protecteurs micro-ondes**.

3.6.110
porte de maintenance
élément de construction de l'appareil qui peut être ouvert ou enlevé avec l'aide d'**outils** afin d'assurer l'accès pour les opérations d'entretien et de réparation

3.6.111
verrouillage micro-ondes
dispositif ou système qui empêche le fonctionnement du générateur de micro-ondes en cas d'apparition avérée ou probable d'une fuite de micro-ondes

Note 1 à l'article: Des exemples de **verrouillages micro-ondes** sont les interrupteurs qui coupent la puissance micro-ondes lorsqu'un **applicateur par contact** est soulevé ou qu'un **applicateur par insertion** est retiré de sa **charge** en cours du fonctionnement, ainsi qu'un dispositif intégré de surveillance des fuites qui agit de la même manière lorsqu'un **applicateur** n'est pas placé suffisamment près de la **charge** ou que l'usager tente de démarrer l'appareil sans **charge**.

3.6.112
ouverture de vision
ouverture dans l'**applicateur**, par laquelle le traitement peut être visuellement contrôlé

3.8 Définitions relatives à des sujets divers

3.8.101
charge
objet à traiter dans lequel l'**applicateur** est inséré ou près duquel ce dernier est placé

3.8.102
personne formée
personne qui est formée et supervisée, qui sait comment éviter tout danger provoqué par le fonctionnement d'un appareil à micro-ondes avec **applicateur par insertion**, **applicateur par contact de grande surface** ou **applicateur par contact de petite surface**

3.8.103
personne qualifiée
personne qui dispose d'une formation professionnelle, de connaissances et d'une expérience pour discerner et éviter tout danger provoqué par le fonctionnement d'un appareil à micro-ondes avec **applicateur par insertion**, **applicateur par contact de grande surface** ou **applicateur par contact de petite surface**

3.8.104
personne ordinaire
personne qui n'est ni une **personne qualifiée** ni une **personne formée**

3.8.105
utilisation prévue
usage de l'appareil prévisible, comme cela est décrit dans les instructions d'emploi, et compatible avec des activités telles que le fonctionnement, le démarrage, l'arrêt, le branchement au réseau d'alimentation ou le débranchement du réseau d'alimentation

3.8.106
commande utilisateur
tout dispositif de **commande** qui doit être actionné par l'opérateur afin d'effectuer des fonctions spécifiques

3.8.107
zone restreinte
espace dans lequel l'appareil fonctionne, plus toute zone extérieure à cet espace dans laquelle le niveau d'exposition à l'appareil dépasse une moyenne de 10 W/m^2 par période de 6 min

Note 1 à l'article: La **zone restreinte** est déterminée en mesurant les fuites micro-ondes à travers le plancher, le mur ou le plafond de la zone de traitement. L'épaisseur de la **charge** dans la direction radiale au départ de l'**applicateur** est prise en compte uniquement si la **charge** est accessible depuis l'arrière pour le mesurage des fuites micro-ondes dans les **conditions de fonctionnement normal**.

3.8.108
interrupteur sans verrouillage
interrupteur qui revient automatiquement en **position arrêt** lorsque son organe de manœuvre est relâché

3.8.109
interrupteur de démarrage
interrupteur sans verrouillage qui doit être actionné par l'opérateur pour que l'**interrupteur de fonctionnement** fonctionne

3.8.110
interrupteur de fonctionnement
interrupteur sans verrouillage qui est conçu pour couper automatiquement le générateur de micro-ondes ou le circuit d'alimentation lorsque la force de manœuvre de l'opérateur est relâchée

4 Exigences générales

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

4.101 En lieu et place des exigences en matière de surveillance des **verrouillages micro-ondes** par les **verrouillages micro-ondes** contrôlés de l'IEC 60335-2-90, la présente norme applique les concepts de **zone restreinte** et de contrôle des fuites micro-ondes de la fonction de **verrouillage micro-ondes** pour les **applicateurs par contact de grande surface** et les **applicateurs par insertion**, ainsi que les concepts d'**interrupteur de démarrage** et d'**interrupteur de fonctionnement** pour les **applicateurs par contact de petite surface**.

5 Conditions générales d'essais

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

5.3 *Modification:*

Au lieu d'effectuer les essais dans l'ordre des articles, ils sont effectués dans l'ordre suivant des articles et paragraphes: Article 32, 22.107, Article 101, Articles 7 à 17, Article 20, Article 21, Article 18, Article 19, Article 22 (à l'exception du 22.107), Articles 23 à 31.

NOTE 101 L'Article 101 traite de la protection contre les fuites par la conception de base des **enceintes micro-ondes** ; l'Article 22 traite des exigences supplémentaires qui s'appliquent lors de la manipulation et contre la manipulation inappropriée de l'appareil, et contre les autres dangers provoqués par les micro-ondes; le 32.1 traite des instruments de mesure des fuites et de leur manipulation, et spécifie les valeurs limites associées.

5.101 La section à micro-ondes de l'appareil est considérée comme un **appareil à moteur**.

6 Classification

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

6.1 *Modification:*

Les appareils à micro-ondes doivent être de la **classe I**.

6.2 *Addition:*

Les **applicateurs par contact de grande surface** et les **applicateurs par insertion** doivent procurer au moins le degré IPX1. Les **applicateurs par contact de petite surface** doivent procurer au moins le degré IPX5.

7 Marquage et instructions

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

7.1

Modification:

Ajouter le nouveau tiret et le texte suivants avant le dernier tiret de la première liste de la Partie 1:

– en substance les mises en garde suivantes, le cas échéant:

- AVERTISSEMENT: Arrêter et débrancher du réseau d'alimentation avant d'effectuer une opération de réglage ou de nettoyage, ou si le câble est enchevêtré ou endommagé.
- AVERTISSEMENT: Tenir le câble d'alimentation souple éloigné des éléments excités par micro-ondes.

Addition:

S'il existe des pictogrammes ou symboles IEC/ISO adéquats, ceux-ci peuvent être utilisés.

Modification:

Ajouter le nouveau texte suivant avant l'alinéa relatif à la conformité:

Le cas échéant, les appareils doivent porter un marquage sur lequel sont apposés les symboles ISO 7000-0434A (2004-01) et IEC 60417-6167 (2012-07).

Les appareils doivent porter le marquage de la fréquence nominale, en mégahertz, de la bande ISM dans laquelle ils fonctionnent.

Les appareils doivent porter un marquage de la **puissance restituée assignée des micro-ondes**.

Une étiquette ou un libellé de contrôle doit être apposé sur les appareils, avec la date de réalisation du dernier contrôle des fuites micro-ondes et du dernier essai fonctionnel effectués conformément au manuel d'entretien.

La conformité est vérifiée par examen.

7.6 *Addition:*

	[symbole IEC 60417-6166 (2012-07)]	attention, rayonnement électromagnétique non ionisant; attention émission de micro-ondes
	[symbole IEC 60417-6167 (2012-07)]	se tenir éloigné du rayonnement à micro-ondes
	[symbole ISO 7010-P004 (2011-05)]	interdit aux piétons

7.12 *Addition:*

Les instructions doivent comporter en substance les indications suivantes.

– AVERTISSEMENT: Si les **barrières micro-ondes** ou les **protecteurs micro-ondes** sont endommagés, l'appareil ne doit pas être mis en fonctionnement tant qu'une **personne qualifiée** n'a pas procédé aux réparations nécessaires;

– AVERTISSEMENT: Il est dangereux pour toute personne n'ayant pas le statut de **personne qualifiée** d'effectuer une opération de maintenance ou de réparation qui implique le retrait d'un couvercle ou d'une barrière assurant une protection contre l'exposition à l'énergie micro-ondes;

– en cas de fumée, arrêter ou débrancher l'appareil;

– si l'appareil n'est pas maintenu dans un bon état de propreté, il peut se dégrader, ce qui peut altérer la durée de vie de l'appareil, voire conduire à une situation dangereuse;

– l'appareil ne doit pas être nettoyé à l'aide d'un jet d'eau.

Les appareils doivent être mis en fonctionnement uniquement par des **personnes formées** ou des **personnes qualifiées**.

Une notice d'instruction doit être fournie avec l'appareil.

Les instructions doivent comprendre:

a) les mises en garde à marquer sur l'appareil ainsi que les explications complémentaires associées, le cas échéant;

b) les spécifications des irrégularités de surface (non-planéité) de la **charge** avec lesquelles l'appareil peut être utilisé;

c) une mention indiquant que l'appareil ne doit pas être utilisé dans de l'eau stagnante;

d) des conseils concernant l'emploi de rallonges et le type de rallonge à utiliser (pas plus légers que ce qui est exigé en 25.7);

e) les instructions relatives au montage et à l'emploi de fixations, le cas échéant;

f) en substance la mise en garde suivante, le cas échéant:

AVERTISSEMENT: Si des éléments des **ouvertures de vision**, des **barrières micro-ondes**, des **protecteurs micro-ondes**, du boîtier ou de tout autre moyen désigné par le fabricant sont endommagés, l'appareil ne doit pas être mis en fonctionnement tant qu'il n'a pas été réparé par une **personne qualifiée**. L'appareil doit être mis hors d'état de fonctionnement de manière permanente (interrupteur à clé, carte à code ou dispositifs analogues, par exemple) tant que les réparations n'ont pas été effectuées. Pour plus d'informations, se reporter aux instructions d'emploi.

Les **personnes formées** doivent être régulièrement formées, au minimum une fois par an, par une **personne qualifiée**. Un enregistrement de la formation dispensée doit être exigé.

1) Formation

- Lire les instructions. Se familiariser avec les **commandes utilisateur** et l'utilisation de l'appareil.
- Ne jamais laisser des **personnes non formées** utiliser l'appareil.

2) Préparation

- Examiner toutes les zones dans lesquelles doit être utilisé l'appareil et enlever tous les corps étrangers.

3) Fonctionnement

- Mettre l'appareil en fonctionnement uniquement à la lumière du jour ou sous une lumière artificielle satisfaisante.
- La clé de l'interrupteur principal ne doit pas rester sur l'appareil lorsque celui-ci est laissé sans surveillance.
- La clé doit être conservée en lieu sûr.
- Faire preuve d'une grande prudence lors de l'inversion ou de l'extraction d'un **applicateur par insertion** ou d'un **applicateur par contact de grande surface** en fonctionnement.
- La surchauffe de **charges** potentiellement inflammables, comme le bois ou certains matériaux composites, peut donner lieu à un échauffement localisé ou interne entraînant la carbonisation, cette carbonisation pouvant provoquer une augmentation du taux d'absorption des micro-ondes et être à l'origine d'un incendie. Il est nécessaire de réduire la valeur de la puissance micro-ondes, et le traitement doit être placé sous surveillance constante. Le risque de condition dangereuse différée doit également faire l'objet d'une attention particulière.
- En cas de fumée, arrêter l'appareil, circonscrire l'incendie à l'aide d'un extincteur, prendre garde au risque de reprise et faire en sorte que la surchauffe ne se propage pas à des espaces non surveillés.
- Ne jamais mettre l'appareil en fonctionnement si les **barrières micro-ondes** ou les **protecteurs micro-ondes** sont défectueux, ou qu'aucun autre dispositif de sécurité n'est en place.
- Mettre sous tension l'appareil conformément aux instructions et en tenant toutes les parties du corps non nécessaires à la manipulation de l'appareil à une distance suffisante de l'**applicateur**.
- Ne pas approcher les mains ou les pieds des **applicateurs**, **barrières micro-ondes** ou **protecteurs micro-ondes**, ni mettre les mains ou les pieds sous ces éléments.
- Retirer la fiche de la prise:
  - avant d'éliminer toute obstruction;
  - avant de contrôler, de nettoyer ou d'intervenir sur l'appareil;
  - lorsque l'appareil a heurté un corps étranger. Examiner l'appareil et, s'il est endommagé, ne pas le mettre en fonctionnement tant qu'il n'a pas été réparé par une **personne qualifiée**.

7.14 *Addition:*

La hauteur des lettres des mises en garde spécifiées en 7.12 doit être d'au moins 3 mm.

La hauteur des lettres des mises en garde spécifiées en 7.101 et en 7.102 doit être d'au moins 5 mm.

Les lettres des mises en garde spécifiées dans l'avant-dernier tiret de la première liste du 7.1 peuvent être en majuscules ou en minuscules, doivent mesurer 5 mm de hauteur au minimum et être inscrites en noir sur fond jaune.

La hauteur du triangle du symbole ISO 7000-0434A (2004-01) et la hauteur du symbole IEC 60417-6167 (2012-07) doivent être d'au moins 50 mm.

Le diamètre du symbole ISO 7010-P004 (2011-05) et la hauteur du triangle du symbole IEC 60417-6166 (2012-07) exigés en 7.102 doivent être d'au moins 150 mm.

Les symboles ISO 7000-0434A (2004-01), IEC 60417-6166 (2012-07) et ISO 7010-P004 (2011-05) doivent satisfaire à l'ISO 3864-1, mais uniquement en ce qui concerne les exigences de couleur spécifiées.

7.15 *Addition:*

Les mises en garde spécifiées dans l'avant-dernier tiret de la première liste du 7.1 doivent être placées de façon visible sur l'appareil.

Le symbole ISO 7000-0434A (2004-01) et le symbole IEC 60417-6167 (2012-07) doivent être placés l'un à côté de l'autre à un emplacement qui laisse apparaître une **barrière micro-ondes** ou un **protecteur micro-ondes**, ou près de l'ouverture aménagée dans la **barrière micro-ondes** d'un **applicateur par contact** situé au-dessus d'une **charge**.

Les mêmes symboles doivent être placés au niveau des **ouvertures de vision** qui comportent des trous d'un diamètre supérieur à 12 mm et qui ne sont pas protégées par des dispositifs de protection visuellement transparents.

Les marquages ou symboles d'avertissement doivent être placés près du danger.

7.101 Le manuel d'entretien ou de réparation doit comporter en substance les indications suivantes:

– AVERTISSEMENT: L'appareil doit satisfaire aux exigences de Articles101 et de 32.1 après chaque réparation et conformément aux instructions du fabricant.

Attention: Les personnes ne doivent pas être exposées à une quantité excessive d'énergie micro-ondes émise par le générateur de micro-ondes. L'ensemble des connexions, guides d'ondes, brides, joints, contacts, etc. de l'**applicateur**, de l'**enceinte micro-ondes**, des **barrières micro-ondes** et des **protecteurs micro-ondes** doivent être construits de manière sûre de telle sorte que les fuites micro-ondes ne dépassent pas la limite admise. La mise en fonctionnement de l'appareil en l'absence de **charge** absorbant les micro-ondes doit être évitée. L'appareil doit faire l'objet d'une maintenance régulière et être maintenu en bon état afin de s'assurer que les fuites micro-ondes ne dépassent pas la limite admise.

Le manuel d'entretien doit en outre spécifier les instructions suivantes:

– la présence des instructions d'emploi doit être vérifiée;

– un contrôle des fuites micro-ondes doit être effectué au moins toutes les 100 h d'utilisation ou à des intervalles plus rapprochés, et cela doit être indiqué dans le manuel d'entretien;

– lors du contrôle des fuites micro-ondes, tous les **verrouillages micro-ondes** doivent être examinés et tous les dispositifs intégrés de surveillance des fuites faisant partie d'un **verrouillage micro-ondes** sont soumis à l'essai afin de vérifier leur bon fonctionnement, conformément aux instructions qui doivent figurer dans le manuel d'entretien;

– une étiquette ou un libellé de contrôle doit être apposé sur l'appareil, avec la date de réalisation du dernier contrôle des fuites micro-ondes et du dernier essai fonctionnel effectués conformément à l'alinéa ci-dessus.

NOTE L'essai des dispositifs intégrés de surveillance des fuites peut consister à désactiver la constante de temps de 20 s du dispositif, rendre les autres **verrouillages micro-ondes** inopérants, puis soulever lentement **l'applicateur par contact de grande surface** dans les **conditions de fonctionnement normal**. L'essai des **applicateurs par insertion** se déroule de la même manière.

7.102 Les instructions suivantes destinées à l'opérateur visent à protéger le grand public contre une exposition aux micro-ondes excessives lors de la mise en fonctionnement d'appareils avec **applicateur par insertion** ou **applicateur par contact de grande surface**:

– L'opérateur doit avoir accès à un instrument conforme au 32.1.

– Examiner les murs, planchers ou plafonds à traiter afin de déceler la présence d'objets métalliques comme de longues pointes, des câbles électriques, des conduites d'eau ou des conduits d'air. Ces objets peuvent dans un premier temps créer une surchauffe locale, puis se comporter comme des antennes et conduire l'énergie micro-ondes. Il est nécessaire de réduire le réglage de puissance micro-ondes, et une attention particulière doit être accordée aux éventuelles fuites micro-ondes à l'extérieur de la zone considérée comme la **zone restreinte**.

– S'assurer que seul l'opérateur peut être présent dans la **zone restreinte**.

– Les limites de la **zone restreinte** sont déterminées en mesurant la puissance surfacique à l'aide d'un instrument tel que celui spécifié en 32.1. Une première série de mesurages est effectuée en plaçant l'appareil dans la position la plus défavorable par rapport aux limites prévues de la **zone restreinte**. La constante de temps de 2 s ou 3 s de l'instrument est alors utilisée. Les endroits correspondant aux valeurs lues les plus élevées sont ensuite réexaminés, en appliquant un temps de moyennage supérieur jusqu'à 6 min.

– Toutes les mesures doivent être consignées dans un journal pour chaque tâche effectuée dans le même bâtiment. En plus du journal, un graphique faisant apparaître l'endroit ou les endroits de l'appareil doit être inclus, ainsi que les points de mesure. Une copie du dessin de plan peut être utilisée à cette fin.

– Étant donné que les limites de la **zone restreinte** peuvent varier dans les **conditions de fonctionnement normal**, ces limites doivent être déterminées une nouvelle fois en procédant à plusieurs mesurages de la puissance surfacique à l'aide d'un instrument tel que celui spécifié en 32.1.

– En cas de doute ou d'absence d'informations pertinentes concernant la construction du bâtiment, la **zone restreinte** doit être agrandie.

NOTE Le verrouillage des portes des pièces situées à l'intérieur de la **zone restreinte** ou l'installation d'une barrière sont des exemples de mesures qui permettent de rendre la **zone restreinte** inaccessible. Les exigences relatives à la stabilité mécanique des installations de barrières sont à l'étude. Cependant, il n'est pas possible d'insérer le calibre d'essai B de l'IEC 61032 à travers l'installation de barrières.

– La **zone restreinte** doit être rendue inaccessible et doit porter un marquage sur lequel sont apposés les symboles ISO 7010-P004 (2011-05) et IEC 60417-6166 (2012-07).

La conformité est vérifiée par examen.

8 Protection contre l'accès aux parties actives

L'article de la Partie 1 s'applique, à l'exception de l'application du calibre d'essai 18 de l'IEC 61032.

9 Démarrage des appareils à moteur

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

9.1 *Addition:*

Les moteurs du **dispositif de transmission** doivent démarrer dans toutes les conditions de tension qui peuvent survenir en cours d'utilisation.

*La conformité est vérifiée en démarrant le moteur à trois reprises à une tension égale à 0,85 fois la **tension assignée**, le moteur se trouvant à température ambiante au début de l'essai.*

*Le moteur est démarré à chaque fois dans les conditions qui se produisent au début des **conditions de fonctionnement normal** ou, pour les appareils automatiques, au début du cycle normal de fonctionnement. Le moteur doit s'arrêter entre deux démarrages successifs. Pour les appareils qui comportent des moteurs équipés d'interrupteurs de démarrage non centrifuges, l'essai est répété à une tension égale à 1,06 fois la **tension assignée**.*

Dans tous les cas, le moteur doit démarrer et doit fonctionner sans compromettre la sécurité, et les dispositifs de protection du moteur contre la surcharge ne doivent pas s'enclencher.

10 Puissance et courant

L'article de la Partie 1 s'applique.

11 Échauffements

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

11.7 *Modification:*

*Les appareils avec **applicateur par contact** destinés au séchage de planchers, murs ou plafonds et les appareils avec **applicateur par insertion** destinés à l'élimination de l'humidité par insertion dans des trous au plancher, au mur ou au plafond sont mis en fonctionnement comme cela est spécifié en 3.1.9 jusqu'à l'établissement des conditions de régime.*

12 Charge des batteries à ions métalliques

L'article de la Partie 1 s'applique.

13 Courant de fuite et rigidité diélectrique à la température de régime

L'article de la Partie 1 s'applique.

14 Surtensions transitoires

L'article de la Partie 1 s'applique.

15 Résistance à l'humidité

L'article de la Partie 1 s'applique.

16 Courant de fuite et rigidité diélectrique

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

16.101 Les enroulements du transformateur de puissance qui alimente le magnétron doivent avoir une isolation adéquate.

La conformité est vérifiée par l'un des essais suivants.

– *Pour les alimentations à découpage, l'isolation entre les enroulements primaire et secondaire des transformateurs d'alimentation à découpage est soumise pendant 1 min à une tension de forme d'onde pratiquement sinusoïdale et d'une fréquence de 50 Hz ou 60 Hz. La valeur de la tension est égale à 1,414 fois la valeur de crête de la **tension de service** secondaire plus 750 V, avec une valeur minimale de 1 250 V.*

  Aucun claquage ne doit se produire entre les enroulements ou entre les spires adjacentes du même enroulement.

– *Pour les autres transformateurs de puissance, une tension égale à deux fois la **tension de service** est induite dans l'enroulement secondaire du transformateur en appliquant aux bornes de l'enroulement primaire une tension sinusoïdale dont la fréquence est supérieure à la **fréquence assignée**.*

  La durée de l'essai est de:

  - *60 s pour des fréquences inférieures ou égales au double de la fréquence assignée; ou*
  - $120 \times \frac{\textbf{fréquence assignée}}{\text{fréquence d'essai}}$ s, *avec une durée minimale de 15 s, pour les fréquences supérieures.*

  NOTE La fréquence de la tension d'essai est supérieure à la **fréquence assignée** pour éviter un courant d'excitation excessif.

  Une tension de valeur maximale égale au tiers de la tension d'essai est appliquée, puis rapidement augmentée sans provoquer de transitoires. À l'issue de l'essai, la tension est réduite d'une manière similaire jusqu'à approximativement un tiers de sa valeur totale avant la mise hors tension.

  Aucun claquage ne doit se produire entre les enroulements ou entre les spires adjacentes du même enroulement.

17 Protection contre la surcharge des transformateurs et des circuits associés

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

Addition:

Les essais ne sont pas effectués sur le transformateur de puissance qui alimente le magnétron et ses circuits associés, ceux-ci étant vérifiés pendant les essais de l'Article 19.

18 Endurance

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

Les **barrières micro-ondes**, les **protecteurs micro-ondes** et autres éléments associés, doivent être construits de façon à résister à l'usure qui peut survenir en usage normal.

La conformité est vérifiée l'essai suivant.

*Les **barrières micro-ondes**, les **protecteurs micro-ondes** et autres éléments associés qui sont manipulés ou utilisés plusieurs fois par jour par une **personne formée** à des fins de contrôle, de correction de **charge** ou d'exécution d'opérations analogues doivent être soumis à 10 000 cycles de fonctionnement.*

*Les **barrières micro-ondes**, **protecteurs micro-ondes** et autres éléments associés qui sont manipulés ou utilisés plusieurs fois par jour à des fins de service doivent être soumis à 300 cycles de fonctionnement.*

Si plusieurs barrières, protecteurs ou dispositifs analogues identiques sont présents, un seul est soumis à l'essai.

Le nombre d'opérations est égal à 6 cycles par minute ou au nombre maximal indiqué pour la construction.

*Après l'essai, les fuites micro-ondes ne doivent pas dépasser la limite spécifiée en 32.1, et les **barrières micro-ondes**, les **protecteurs micro-ondes** et autres éléments associés doivent toujours fonctionner.*

NOTE 101 Les **commandes utilisateur** peuvent être rendus inopérantes pour effectuer l'essai.

NOTE 102 Les composants dont la détérioration ne compromet pas la conformité à la présente norme peuvent être remplacés pour mener l'essai à son terme.

19 Fonctionnement anormal

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

19.11.2 *Addition:*

*Le circuit anode-cathode d'un magnétron est successivement ouvert et court-circuité. Si l'une de ces conditions de défaut entraîne un courant d'entrée qui augmente lorsque la tension diminue, l'essai est effectué en alimentant l'appareil à une tension égale à 0,94 fois la **tension assignée**. Cependant, si le courant d'entrée augmente plus que proportionnellement par rapport à la tension, l'appareil est alimenté à une tension égale à 1,06 fois la **tension assignée**.*

Le filament d'un magnétron n'est pas court-circuité.

19.101 *Le **dispositif de transmission** des appareils avec **applicateur par contact** est neutralisé, et l'appareil est mis en fonctionnement sur une surface métallique horizontale qui dépasse les dimensions horizontales de l'appareil d'au moins 70 mm de chaque côté, en lieu et place de la **charge** normale.*

La durée de fonctionnement est le temps maximal autorisé par la minuterie ou le temps nécessaire pour établir les conditions de régime, si cette durée est plus courte.

L'essai du 32.101 est ensuite effectué, sans tige.

19.102 *Les appareils avec **applicateur par contact de grande surface** ou **applicateur par contact de petite surface** sont mis en fonctionnement en réglant les **commandes utilisateur** sur la position la plus défavorable et en les plaçant sur une surface métallique horizontale qui dépasse les dimensions horizontales de l'appareil d'au moins 70 mm de chaque côté, en lieu et place de la **charge** normale.*

*Les appareils avec **applicateur par contact de petite surface** sont en outre mis en fonctionnement en réglant les **commandes utilisateur** sur la position la plus défavorable et en les maintenant dans l'espace libre, en lieu et place de la **charge** normale.*

*Les appareils avec **applicateur par insertion** sont mis en fonctionnement en réglant les **commandes utilisateur** sur la position la plus défavorable et en les plaçant dans un tube métallique qui possède un fond métallique et un anneau métallique à l'extrémité du côté insertion, avec un diamètre et une longueur qui dépassent les dimensions de l'élément de l'appareil destiné à être inséré, en lieu et place de la **charge** normale.*

La durée de fonctionnement des appareils est le temps maximal autorisé par la minuterie ou le temps nécessaire pour établir les conditions de régime, si cette durée est plus courte.

L'essai du 32.101 est ensuite effectué, sans tige.

19.103 *Les appareils sont mis en fonctionnement dans les **conditions de fonctionnement normal**, en mettant en court-circuit la minuterie ou les autres **commandes utilisateur** qui fonctionnent en usage normal. Si l'appareil comporte plusieurs **commandes utilisateur**, ceux-ci sont successivement court-circuités. Ces courts-circuits sont appliqués successivement.*

19.104 *Les appareils sont mis en fonctionnement dans les **conditions de fonctionnement normal** et en simulant les conditions de premier défaut susceptibles de se produire. Les **commandes utilisateur** sont réglées sur la valeur la plus défavorable, et les appareils avec **applicateur par contact** ou **applicateur par insertion** sont mis en fonctionnement pendant le temps maximal autorisé par la minuterie, jusqu'à l'établissement des conditions de régime ou pendant 90 min, si cette durée est plus courte.*

NOTE Les conditions de défaut sont par exemple:

– l'obturation des ouvertures d'air sur un même plan;

– le blocage du rotor des moteurs si le couple de démarrage du rotor bloqué est inférieur au couple à pleine **charge**;

– le blocage des parties mobiles susceptibles d'être coincées.

19.105 *Les interrupteurs de position de la **commande** d'inversion du **dispositif de transmission** des appareils avec **applicateur par contact de grande surface** sont neutralisés, et l'appareil est mis en fonctionnement de la manière décrite en 3.1.9.*

La durée de fonctionnement est le temps maximal autorisé par la minuterie ou le temps nécessaire pour établir les conditions de régime, si cette durée est plus courte.

20 Stabilité et dangers mécaniques

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

20.1 *Addition:*

*Les **portes de maintenance** qui peuvent être ouvertes, les couvercles et les accessoires doivent être placés dans la position la plus défavorable.*