IEC 60335-2-110

Edition 1.1 2019-10
CONSOLIDATED 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 60335-2-110:2013-09+AMD1:2019-10 CSV(en)

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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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This consolidated version of the official IEC Standard and its amendment has been prepared for user convenience.

IEC 60335-2-110 edition 1.1 contains the first edition (2013-09) [documents 61B/477/FDIS and 61B/483/RVD] and its amendment 1 (2019-10) [documents 61B/613/CDV and 61B/637/RVC as well as 61B/614/CDV and 61B/638/RVC].

In this Redline version, a vertical line in the margin shows where the technical content is modified by amendment 1. Additions are in green text, deletions are in strikethrough red text. A separate Final version with all changes accepted is available in this publication.

This part of International Standard IEC 60335 has been prepared by subcommittee SC61B: Safety of microwave appliances for household and commercial use, of IEC technical committee 61: Safety of household and similar electrical appliances.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

This part 2 is to be used in conjunction with the latest edition of IEC 60335-1 and its amendments. It was established on the basis of the fifth edition (2010) of that standard.

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

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

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.

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.

The committee has decided that the contents of the base publication and its amendment will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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- withdrawn,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

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

IMPORTANT – The 'colour inside' logo on the cover page of this publication 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.

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 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 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.

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 International Standard 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.

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).

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**.

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 (series of IEC 61010);

– 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 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.

3.1.7 *Addition:*

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

3.1.9 *Replacement:*
normal operation
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 be impractical, since it may 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.

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

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

3.104
microwave transparency
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
insertion applicator
applicator for insertion into the **load**, in which all **available microwave power** is intended to be absorbed

3.106
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
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

3.108
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
available microwave power
the 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.

3.110
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
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
ordinary person
person who is neither a **skilled person** nor an **instructed person**

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

3.114
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
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
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
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
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**.

3.119
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
control
any control device requiring the operator's actuation to perform specific functions

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

3.122
restricted area
the space where the operation of the equipment takes place, plus any area outside this where the exposure level from the equipment may exceed 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
biased-off switch
switch that automatically returns to the **off-position** when its actuating member is released

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

3.125
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: 32, 22.107, 101, 7 to 17, 20, 21, 18, 19, 22 (except 22.107), 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; Clause 32 deals with the leakage measurement instrumentation and handling, plus limiting values.

5.101 *Addition:*

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 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.

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

Add the following new text before the compliance paragraph of Part 2-110:

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

Addition:

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, 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 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.

~~The substance of the following warnings, if applicable, shall be placed in a prominent position on the appliance. The letters, which may be in upper or lower case, shall be a minimum of 3 mm high, in black on a yellow background. Where appropriate IEC/ISO symbols or pictograms are available, they may be used. Markings or symbols giving cautionary information shall be located close to the hazard.~~

~~– 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.~~

~~A microwave warning sign (IEC 60417-5140 (2003-04)) of a size specified in IEC 60417, shall be placed 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 warning text shall include the substance of the following:~~

~~WARNING~~

~~MICROWAVE ENERGY~~

~~DO NOT INSERT THE HAND OR FOREIGN OBJECTS~~

~~The same type of warning sign shall be placed at **viewing openings** with holes larger than diameter 12 mm and which are not protected by visually transparent protective devices. A warning not to insert objects shall also be given.~~

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 **controls** and the proper use of the appliance.
   - Never allow people unfamiliar with these instructions to use the appliance.
2) Preparation
   - Thoroughly inspect the area 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 be locally and internally heated to charring, which may in turn cause the microwave absorption rate to increase so that a fire occurs. The microwave power setting may need 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 warning specified in 7.12 shall be in lettering at least 3 mm high.

The warning 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 7.1, which may 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 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 Clauses 101 and 32 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, 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 Clause 32.
– 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 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 Clause 32. 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 change during **normal operation** the boundaries shall be re-determined by several measurements of power flux density with an instrument as specified in Clause 32.

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

~~– The **restricted area** shall be made inaccessible and be clearly marked. The symbol (see IEC 60417-5140 (2003-04)) below shall be used and the substance of the following shall also be included along with the symbol:~~

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.

~~WARNING~~

~~MICROWAVE ENERGY~~

~~DO NOT ENTER~~

– 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.

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 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

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.

16.101.1 *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 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 *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*

– $120 \times \frac{\text{rated frequency}}{\text{test frequency}}$ *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 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 Clause 32 and ***microwave barriers***, ***microwave guards*** *and other associated parts shall still function.*

NOTE 101 **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. 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* ***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* ***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* ***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 **controls** that operate in normal use short-circuited.*

NOTE If the appliance is provided with more than one **control**, these are short-circuited in turn.

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.

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 Clause 32.

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 Clause 32.

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 Clauses 8 and 32.*

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 Clause 32.

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 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 ~~if they indicate danger, alarm or similar situations~~.

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 Clause 32.

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 Clause 32.

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 *Addition:*

NOTE 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 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.

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:*

Subclause 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.

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/m2 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, 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. 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, is 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.

*The dimensional and microwave leakage measurement requirements on **microwave barriers** in relation to the dimension and type of opening are given in Table 101. 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 – 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

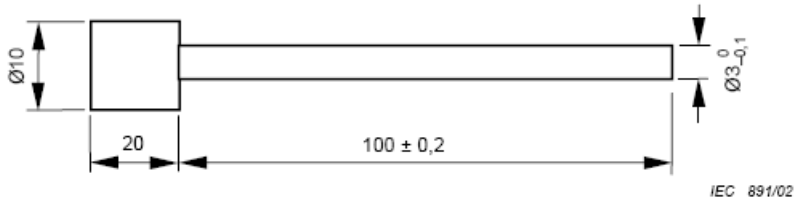
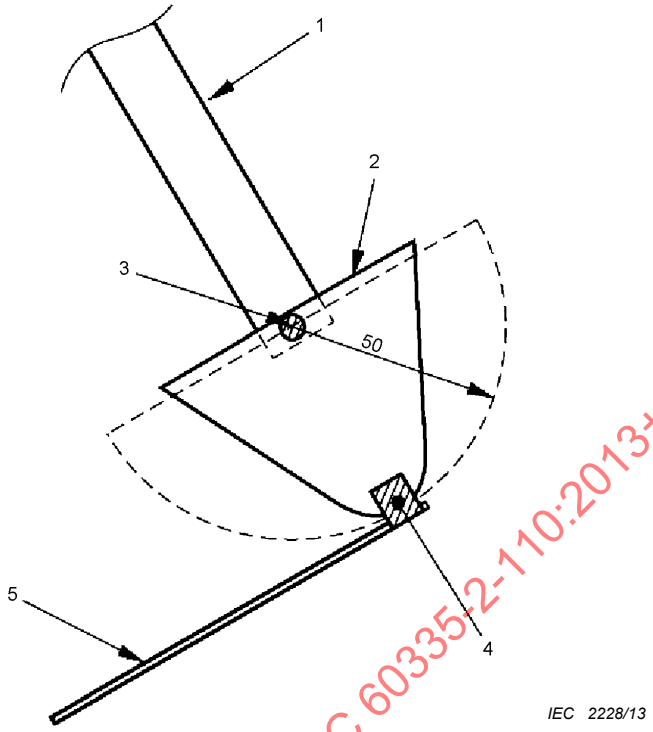


Figure 101 – Test rod for interlock concealment



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

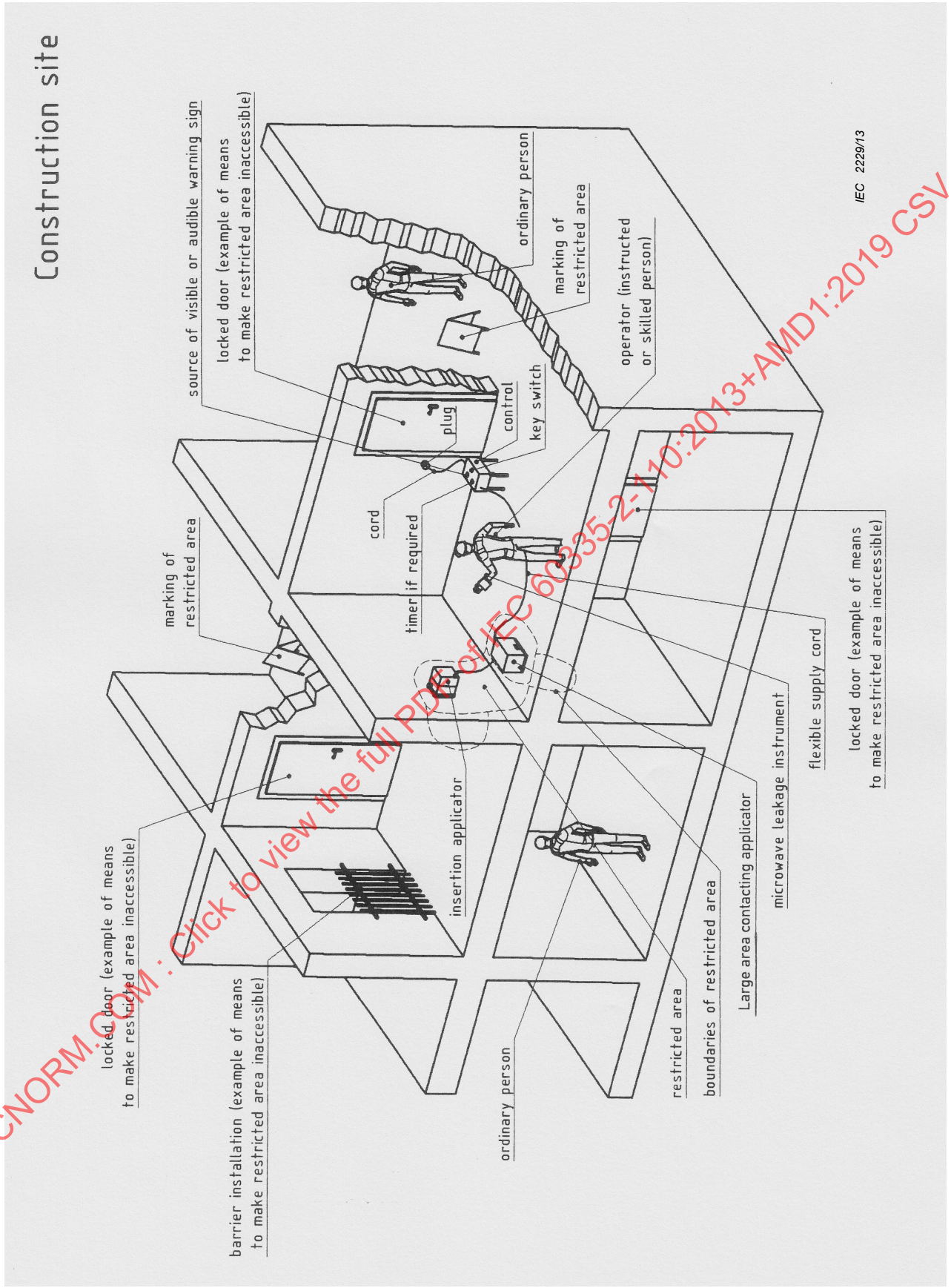


Figure 103 – Construction site, overview of different applicator types and their use

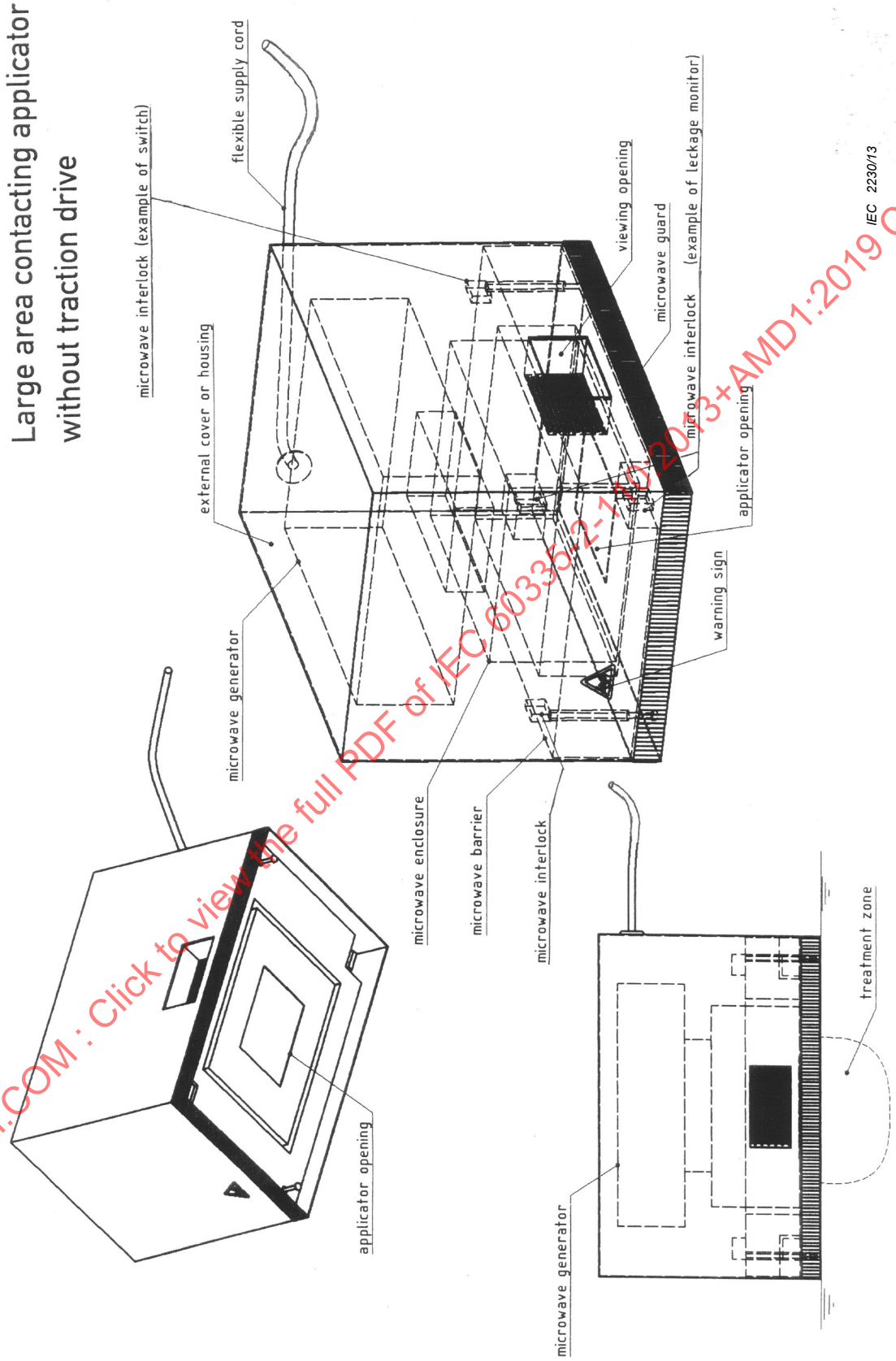


Figure 104 – Large area contacting applicator without traction drive

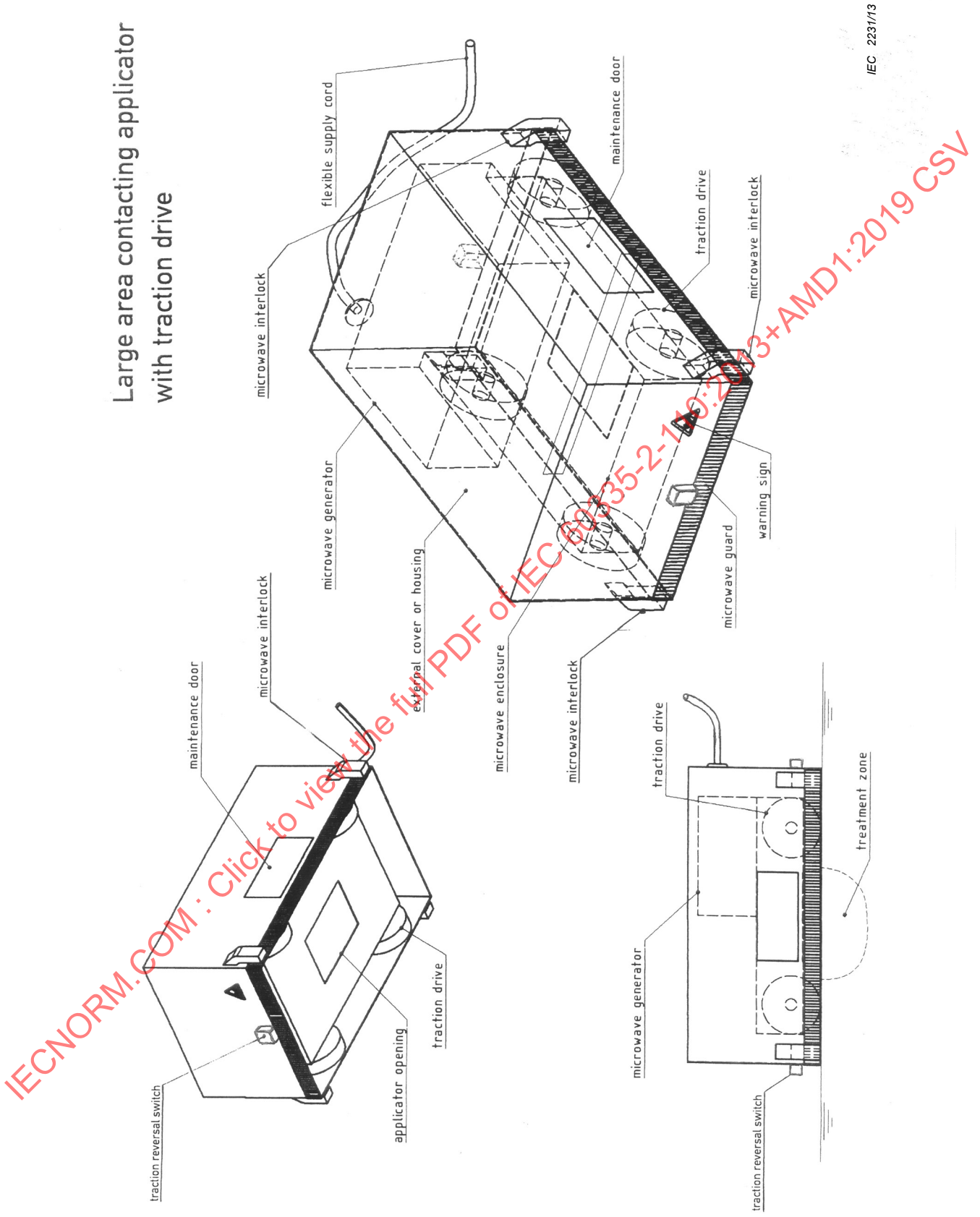


Figure 105 – Large area contacting applicator with traction drive

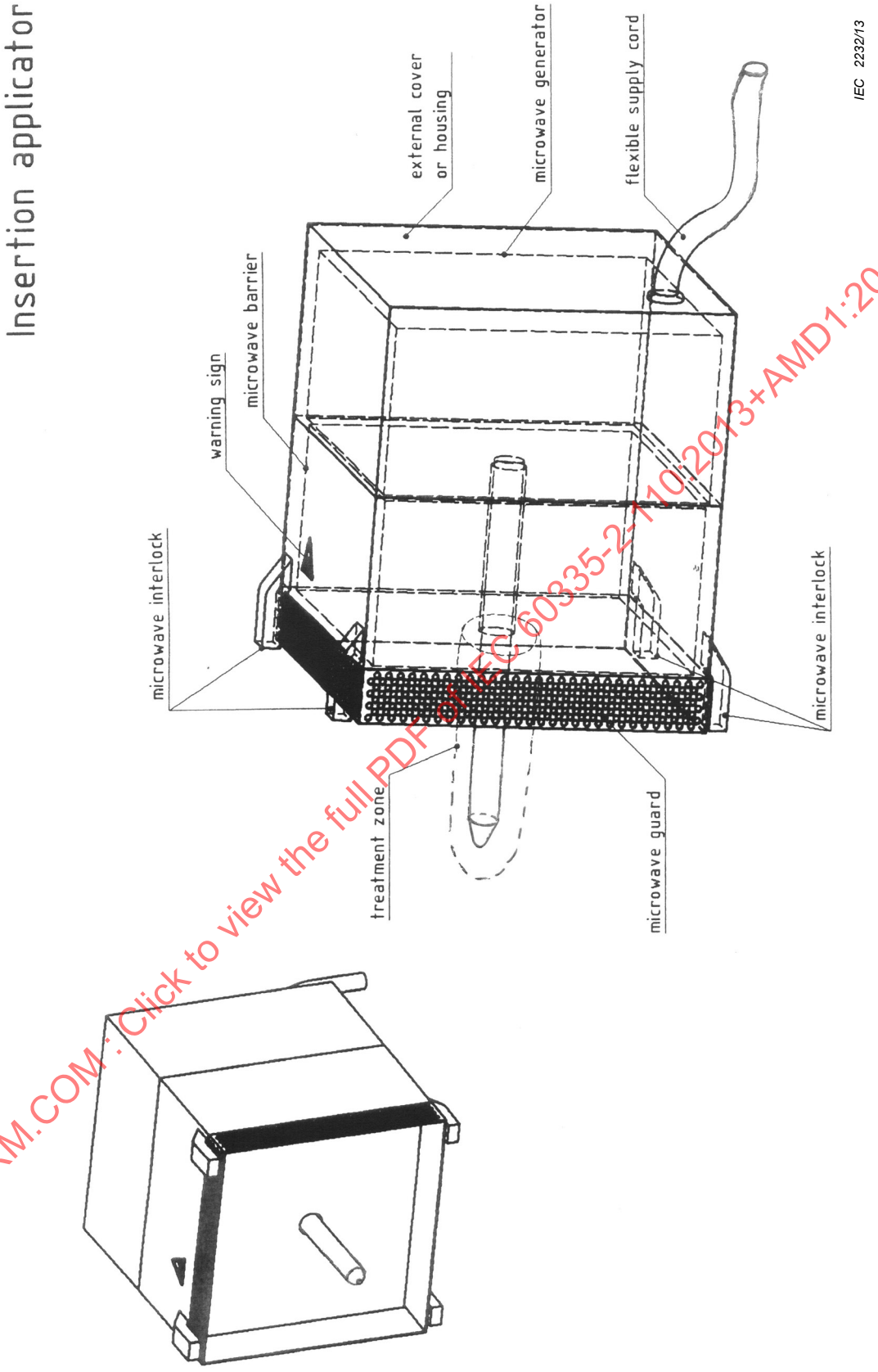
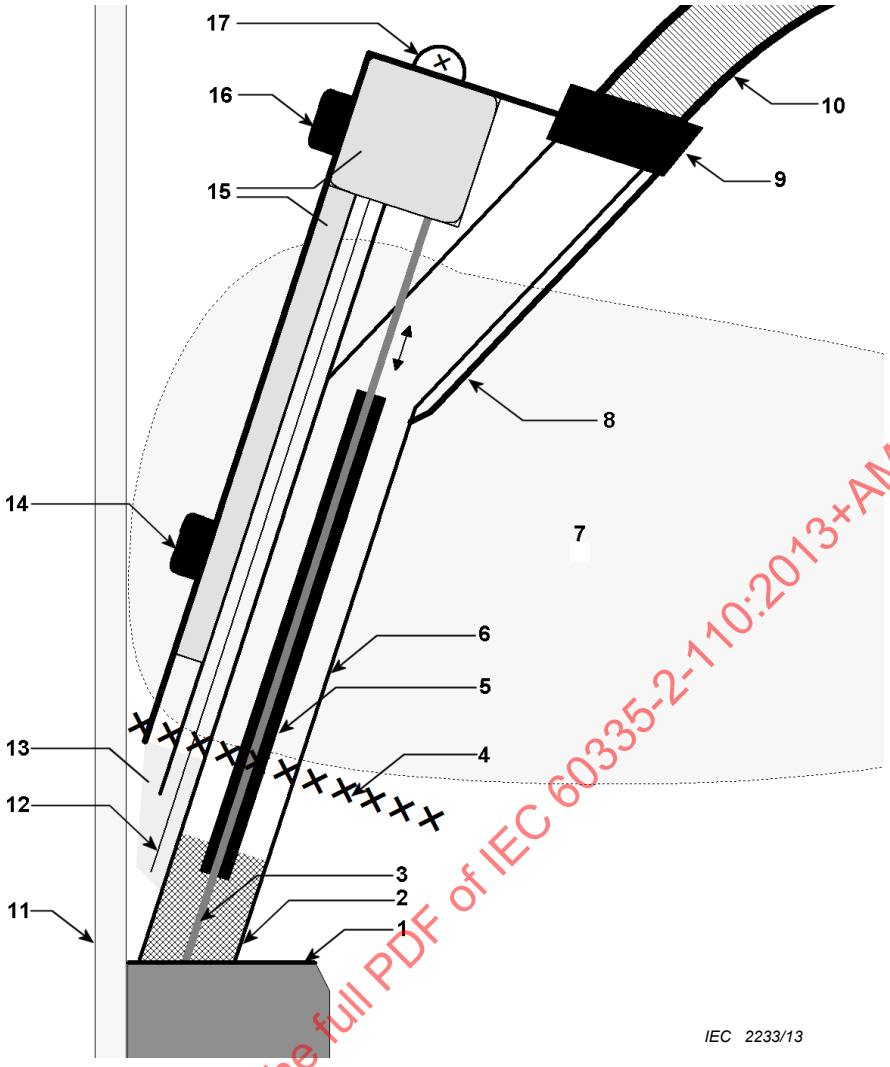


Figure 106 – Insertion applicator



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

Annex AA
(informative)

Rationales for the microwave barrier and associated leakage tests

AA.1 The 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 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 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 Clause 32.

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 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 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 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 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 extend further out than from an oven door. Hence, the construction of the **applicators** and barriers as well as the measurement method must 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 – 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 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 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 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:

- 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 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 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 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 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 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 The 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 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 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 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 a 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 the standard 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 the standard 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 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 – Part 6: Specifications for safety in industrial microwave heating 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, *Separating transformers, autotransformers, variable transformers and reactors*

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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

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IEC 60335-2-110 edition 1.1 contains the first edition (2013-09) [documents 61B/477/FDIS and 61B/483/RVD] and its amendment 1 (2019-10) [documents 61B/613/CDV and 61B/637/RVC as well as 61B/614/CDV and 61B/638/RVC].

This Final version does not show where the technical content is modified by amendment 1. A separate Redline version with all changes highlighted is available in this publication.

This part of International Standard IEC 60335 has been prepared by subcommittee SC61B: Safety of microwave appliances for household and commercial use, of IEC technical committee 61: Safety of household and similar electrical appliances.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

This part 2 is to be used in conjunction with the latest edition of IEC 60335-1 and its amendments. It was established on the basis of the fifth edition (2010) of that standard.

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

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

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.

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.

The committee has decided that the contents of the base publication and its amendment will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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

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

IMPORTANT – The 'colour inside' logo on the cover page of this publication 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.

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 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 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.

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 International Standard 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.

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).

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**.

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 (series of IEC 61010);

– 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 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.

3.1.7 *Addition:*

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

3.1.9 *Replacement:*
normal operation
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 be impractical, since it may 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.

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

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

3.104
microwave transparency
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
insertion applicator
applicator for insertion into the **load**, in which all **available microwave power** is intended to be absorbed

3.106
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
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

3.108
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
available microwave power
the 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.

3.110
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
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
ordinary person
person who is neither a **skilled person** nor an **instructed person**

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

3.114
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
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
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
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
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**.

3.119
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
control
any control device requiring the operator's actuation to perform specific functions

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

3.122
restricted area
the space where the operation of the equipment takes place, plus any area outside this where the exposure level from the equipment may exceed 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
biased-off switch
switch that automatically returns to the **off-position** when its actuating member is released

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

3.125
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: 32, 22.107, 101, 7 to 17, 20, 21, 18, 19, 22 (except 22.107), 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; Clause 32 deals with the leakage measurement instrumentation and handling, plus limiting values.

5.101 *Addition:*

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 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.

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

Add the following new text before the compliance paragraph of Part 2-110:

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

Addition:

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, 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 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 **controls** and the proper use of the appliance.
- Never allow people unfamiliar with these instructions to use the appliance.

2) Preparation

- Thoroughly inspect the area 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 be locally and internally heated to charring, which may in turn cause the microwave absorption rate to increase so that a fire occurs. The microwave power setting may need 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 warning specified in 7.12 shall be in lettering at least 3 mm high.

The warning 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 7.1, which may 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 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 Clauses 101 and 32 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, 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 Clause 32.

– 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 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 Clause 32. 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 change during **normal operation** the boundaries shall be re-determined by several measurements of power flux density with an instrument as specified in Clause 32.

– 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.

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 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

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.

16.101.1 *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 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 *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*

– $120 \times \frac{\text{rated frequency}}{\text{test frequency}}$ *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 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 Clause 32 and **microwave barriers**, **microwave guards** and other associated parts shall still function.*

NOTE 101 **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. 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 **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 **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 **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 **controls** that operate in normal use short-circuited.*

NOTE If the appliance is provided with more than one **control**, these are short-circuited in turn.

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.

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 Clause 32.

*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 Clause 32.

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 Clauses 8 and 32.*

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 Clause 32.

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 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 Clause 32.

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 Clause 32.

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 *Addition:*

NOTE 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.