IEC 60519-6

Edition 3.0 2011-01

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Safety in electroheat installations –
Part 6: Specifications for safety in industrial microwave heating equipment

Sécurité dans les installations électrothermiques –
Partie 6: Spécifications pour les installations de chauffage industriel à hyperfréquences

IEC 60519-6:2011

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

PRICE CODE
CODE PRIX U

ICS 25.180.10

ISBN 978-2-88912-322-3

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

SAFETY IN ELECTROHEAT INSTALLATIONS –

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FOREWORD

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International Standard IEC 60519-6 has been prepared by IEC technical committee 27: Industrial electroheating.

This third edition cancels and replaces the second edition published in 2002 and constitutes a technical revision. The significant changes with respect to the previous edition are as follows:

– the third edition of IEC 60519-1:2003 has been taken into account (the structure of clauses was adapted to it as far as practicable);
– some definitions are modified or brought into line with IEC 60050-841:2004;
– clauses on abnormal operation, access openings, microwave enclosure and barriers are added;
– the microwave leakage measurements are in a normative Annex A;
– an informative Annex B on the rationales for microwave exposure and leakage limits is added;
– Bibliography is added.

This part of IEC 60519 is to be used in conjunction with IEC 60519-1:2003. It is intended to specify particular requirements for industrial microwave heating equipment. This Part 6 supplements or modifies the corresponding clauses of IEC 60519-1, so as to convert it into an IEC standard. Where a particular subclause of Part 1 is not mentioned in this Part 6, that subclause applies as far as is reasonable. Where this standard states "addition", modification" or "replacement", the relevant text of Part 1 is to be adapted accordingly.

NOTE Subclauses and notes which are additional to those in Part 2 are numbered starting from 101, additional items and annexes are lettered aa, bb or AA, BB, etc.

The text of this standard is based on the following documents:

CDV	Report on voting
27/704/CDV	27/752/RVC

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

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

The list of all parts of the IEC 60519 series, under the general title *Safety in electroheat installations*, can be found on the IEC website.

The committee has decided that the contents of this publication 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.

INTRODUCTION

This edition of IEC 60519-6 contains updates and revisions of IEC 60519-6:2002, which was used over several years. It specifies safety requirements for industrial microwave heating equipment and installations specially designed for specific applications, unlike household, commercial and laboratory microwave appliances. Criteria for discrimination between these categories are dealt with in the scope.

SAFETY IN ELECTROHEAT INSTALLATIONS –

Part 6: Specifications for safety in industrial microwave heating equipment

1 Scope

This part of IEC 60519 is applicable to equipment using microwave energy alone or in combination with other kinds of energy for industrial heating of materials.

This part is applicable to industrial microwave heating equipment operating in the frequency range 300 MHz to 300 GHz.

NOTE 1 Since the wavelength of the high end of the microwave band at 300 GHz is very short and particular leakage measurement instrumentation is needed in the low end of the band, the microwave leakage specification in Annex A applies only for the ISM frequencies between 800 MHz and 6 GHz. The centre frequencies of these are 2,45 GHz and 5,8 GHz universally, and between 896 MHz and 918 MHz in some regions. For such microwave equipment IEC 62311 applies. For other microwave frequencies, the basic restriction as addressed in informative Annex B or the ICNIRP Guidelines (see Bibliography) may be used.

This part does not apply to appliances for household and similar use (covered by IEC 60335-2-25), commercial use (covered by IEC 60335-2-90) or laboratory use (covered by IEC 61010-2-010).

NOTE 2 Since microwave tunnel ovens and also some other types of microwave equipment may be either for commercial, laboratory or industrial use, the following criteria are suitable for determination of the classification as industrial equipment:

– commercial equipment is typically designed and planned for series production of many identical units, whereas industrial equipment is typically produced in small series or even as single units. The processed goods are consumed or ready for final use at the end of the heating process.

– laboratory heating equipment is for preparing material in a laboratory environment, and the processed material is immediately available for investigations or further processing. Regular production of large quantities of material is not foreseen.

– with industrial equipment, the processed goods are not immediately accessible to the end user, and the goods may additionally not be in a final state from the perspective of the end user.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050-841:2004, *International Electrotechnical Vocabulary – Part 841: Industrial electroheat*

IEC 60417, *Graphical symbols for use on equipment*

IEC 60519-1:2003, *Safety in electroheat installations – Part 1: General requirements*

IEC 61307, *Industrial microwave heating installations – Test methods for the determination of power output*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60519-1:2003 and IEC 60050-841, as well as the following apply.

3.1
microwave generator
source used to produce electromagnetic energy in the frequency range from 300 MHz to 300 GHz

[IEC 60050-841:2004, 841-29-16]

3.2
microwave applicator
structure which applies the microwave energy to the load

[IEC 60050-841:2004, 841-29-11]

3.3
microwave cavity
space enclosed by inner metal walls and a door or an access opening and in which the load is placed

[IEC 60050-841:2004, 841-29-19]

3.4
microwave load
objects introduced into the microwave applicator or microwave cavity

[IEC 60050-841:2004, 841-29-12, modified]

3.5
microwave heating equipment
assembly of electric and mechanical devices intended for the transfer of microwave energy to the microwave load and comprising in general power supplies, microwave applicators or cavities, interconnecting cables and waveguides, control circuitry, means for transporting the microwave load, and ventilation equipment

[IEC 60050-841:2004, 841-29-06, modified]

3.6
microwave leakage
superficial power density of microwave radiation escaping from the microwave heating equipment

3.7
microwave access barrier
physical barrier, which has the property of microwave transparency, limiting access to the microwave enclosure, mounted outside the microwave enclosure and can only be removed with the aid of tools

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

NOTE 2 Microwave access barriers may be fixed to the microwave heating equipment or not, and are in the latter case a part of the installation.

NOTE 3 Devices such as an array of metal chains or hinged metal plates at entrance and exit ports intended to reduce microwave leakage are not considered microwave access barriers.

3.8
microwave enclosure
structure which is intended to confine the microwave energy to a defined region

NOTE 1 Examples are a cavity, door seals and waveguides.

NOTE 2 Microwave access barriers mounted outside the microwave enclosure are not considered as a part of the microwave enclosure.

[IEC 60050-841:2004, 841-29-20, modified]

3.9
means of access
all structural features of the microwave heating equipment which can be opened or removed without the use of a tool to provide access to the interior of the microwave applicator or microwave cavity

3.10
maintenance door
all structural features of any part of the microwave heating equipment which can be opened or removed without the use of a tool to provide access to other locations than the microwave applicator or microwave cavity

3.11
cover
structural feature of any part of the microwave heating equipment which can be opened or removed by the use of a tool to provide access for routine maintenance, service, replacement of expendable parts, etc.

3.12
entrance or exit port
openings in the microwave enclosure through which the microwave load moves

3.13
microwave transparency
property of a material having negligible absorption and reflection of microwaves

NOTE The relative permittivity of a microwave transparent material is usually less than 7 and the loss factor is usually less than 0,015.

[IEC 60050-841:2004, 841-29-14]

3.14
interlock
mechanical or electrical safety device or system, the function of which is to prohibit one class of events if another class of condition does not exist

NOTE For example, a microwave interlock prohibits the operation of a microwave generator, if the means of access are not closed.

3.15
microwave output power
microwave power as defined and measured according to IEC 61307

3.16
normal load
nominal microwave load at full microwave output power as specified by the manufacturer's documentation

3.17
normal operation
range of microwave output power and normal loads in allowable working conditions of the microwave heating equipment, as agreed between the manufacturer and user

3.18
reference surface
fictitious surface in the vicinity of mainly entrance and exit ports, located as a consequence of microwave leakage measurements

NOTE 1 If the microwave leakage reading without microwave access barrier is less or equal to the limits of Annex A, the reference surface is the surface of the geometric opening of the microwave enclosure.

NOTE 2 See 6.3 and Figures A.1, A.2 and A.3 for further explanations.

4 Classification of electroheat equipment according to voltage bands

Clause 4 of IEC 60519-1:2003 applies.

5 Classification of electroheat equipment according to frequency bands

Clause 5 of IEC 60519-1:2003 applies.

6 General requirements

Clause 6 of IEC 60519-1:2003 applies except as follows.

6.1 Electroheating equipment

Additional subclause:

6.1.101 Abnormal operation

Any single electrical or mechanical fault in the microwave heating equipment shall not result in energising of a microwave generator under normal operation.

NOTE 1 A mechanical fault in an array of metal chains or hinged metal plates at entrance and exit ports intended to reduce microwave leakage, is a single fault condition.

NOTE 2 Compliance with this requirement may be checked by inspection of the circuit diagrams and/or with the microwave leakage measurement as specified in Annex A.

For the purpose of testing, all maintenance doors, means of access and microwave access barriers are removed or opened, except those which incorporate microwave interlocks which prohibit generation of microwave power when removed or open. Attempts of normal operation are then made and shall not result in microwave leakage exceeding the limit in Annex A.

Operation of microwave heating equipment for continuous processing under conditions of interruption of the flow of microwave load(s) shall not result in a temporary microwave leakage exceeding the limit specified in Annex A, but with a limit of 100 W/m^2.

Attempts to operate the microwave heating equipment without microwave load shall not result in microwave leakage exceeding the limit specified in Annex A, but with a limit of 100 W/m^2.

NOTE 3 Compliance with this requirement can be checked by detecting microwave emission by an active microwave leakage monitor which switches off the microwave generator in order for the requirements of Annex A to be fulfilled. Defeating the sensor circuit is considered a single fault condition, as is interruption of the flow of microwave load(s).

6.3 Static charges – stray fields – electric and/or magnetic fields

Additional subclauses:

6.3.101 Microwave leakage

Compliance for microwave leakage with the safety requirements is checked by measurements according to Annex A.

6.3.102 Protection against microwave leakage

Microwave heating equipment shall be designed, constructed and operated as to provide adequate protection against radiation hazards due to microwave leakage.

The microwave heating equipment shall be provided with a device giving adequate indication when the microwave power is switched on and which is clearly visible to anyone entering the general area of the installation.

Where the microwave power can be or is varied by a user control, an indicator shall show the operator the level of microwave power applied.

There shall be a key switch, code panel, card reader or similar device on the control panel requiring the insertion of a key, input of a code or card or similar before microwave power can be generated.

6.3.103 Protection against access to microwave containing regions

Microwave heating equipment including microwave access barriers installed in order to limit access of personnel to a distance from the microwave enclosure are either enclosing the entrance or exit port and mounted on the microwave heating equipment, or not a part of it but of the installation and may then be essentially only vertical. Both types shall comply with the following:

- the microwave access barrier shall not be constructed of metal or microwave-absorbing material in such a way that it can guide or absorb microwaves;
- dimensions of the accessible opening of the microwave access barrier as such shall not be larger than the openings of the microwave enclosure which they protect, with a maximum of 65 mm × 65 mm; the requirement of maximum dimensions 65 mm × 65 mm is not applicable for any openings in microwave access barriers through which the microwave loads move;
- the microwave access barrier shall either be removable only with the aid of a tool, or its removal shall operate at least one interlock;
- microwave access barriers that are only vertical and located along the microwave load transport direction shall start at maximum 75 mm and end at least 1 800 mm above the floor.

NOTE 1 Microwave access barriers that are only vertical may be supported by some few metal poles or similar.

NOTE 2 For microwave access barriers which are not fixed to the microwave heating equipment and are instead a part of the installation, 15.2.7 also applies.

NOTE 3 The ≤65 mm × 65 mm requirement on accessible opening dimensions are for prohibiting insertion of the human hand, as is the <Ø 75 mm requirement in Table 1. The ≥1 800 mm barrier height requirement, with the warning sign in 15.2.7, is for making it obvious that access is not allowed; the ≤75 mm limit is for prohibiting access by arm's length while simplifying cleaning of the floor.

The dimensional and location requirements on microwave access barriers in relation to the type of barrier and the dimension and type of opening are given in Table 1. The barrier geometry is calculated from the reference surface. In order for this to be determined, microwave access barriers are removed and their associated interlocks are defeated.

The location of the reference surface is determined as follows. Microwave leakage is measured according to Annex A. The spacer tip of the microwave leakage instrument is moved over and away from the external surface of the microwave heating equipment to locate the highest microwave leakage, particular attention being given the openings. The region inside a geometric opening into the microwave enclosure is not regarded as accessible during these measurements.

If the microwave leakage reading is less than the limit of Annex A, the reference surface is at the surface of the geometric opening of the microwave enclosure.

If the microwave leakage reading exceeds the limit of Annex A, the locations of the sensor (not the tip) further away from the microwave enclosure where this value is measured are recorded. The position of the reference surface away from the surface of the microwave heating equipment is then determined as 50 mm straight inwards from these sensor positions and towards the surface of the microwave heating equipment.

Table 1 – Dimensional requirements on microwave access barriers

Opening dimension	Allowed use	Required barrier length	Notes on microwave frequencies
Allows the insertion of a Ø 75 mm or 65 mm × 65 mm object	Entrance or exit ports, and microwave access barriers that are only vertical	5 × the minor axis length of an ellipse inscribing the opening, but maximum 850 mm from the reference surface; only sideways/ behind for microwave access barriers that are only vertical	At about 915 MHz, there is unattenuated propagation in a 160 mm long but narrow slot, and an energy decay distance of about 50 mm in a Ø 130 mm opening. However, loads may convey surface waves.
Allows the insertion of an object with dimensions between Ø 75 mm and 20 mm × 50 mm	Entrance or exit ports, and microwave access barriers that are only vertical	180 mm from the reference surface; only sideways/ behind for microwave access barriers that are only vertical	At Ø 75 mm, the energy decay distance is about 2 mm at about 915 MHz, and very long at 2,45 GHz. There is unattenuated propagation at 5,8 GHz. However, high permittivity loads may convey surface waves.
Allows the insertion of an object with dimensions between 20 mm × 50 mm and Ø 12 mm	Any purpose	80 mm from the reference surface	At 20 mm × 50 mm, cut-off is very efficient for about 915 MHz; the energy decay distance is 30 mm at 2,45 GHz and there is unattenuated propagation at 5,8 GHz. However, continuous high permittivity loads may convey surface waves.
Allows the insertion of an object with dimensions less than Ø 12 mm	Any purpose	—	There is a very efficient cut-off for all ISM frequencies. Surface wave propagation at continuous loads in the opening may exist.

The minimum distance between the plane of a meshed microwave access barrier and the reference surface shall be according to Table 1, using the mesh opening dimensions. The same principle applies to the barrier start height above the floor.

In the determination of the location of microwave access barriers that are only vertical and located along the microwave load transport direction, the horizontal projection of the maximum extension of the reference surface shall be used.

NOTE 4 In order to simplify the design of microwave access barriers, the projections of the maximum horizontal and vertical extensions of the reference surface is normally used. This, and the use of Table 1 are exemplified in Figures A.1, A.2 and A.3.

6.5 Ionizing radiation

Addition:

The X-ray leakage from the generator, measured in the same locations as specified in 6.3.5, shall not exceed the value specified by national authorities responsible for public health.

7 Isolation and switching

Clause 7 of IEC 60519-1:2003 applies.

8 Connection to the supply network and internal connections

Clause 8 of IEC 60519-1:2003 applies.

9 Protection against electric shock

Clause 9 of IEC 60519-1:2003 applies except as follows.

9.1 General

Addition:

NOTE Microwave frequencies do not cause electric shock.

Additional subclause:

9.101 Accessibility to high voltage parts

Maintenance doors allowing access to high voltage parts and/or the microwave generator for maintenance shall be provided with key locks.

NOTE If microwave exposure may also occur, Subclause 12.3.2 applies.

10 Protection against overcurrent

Clause 10 of IEC 60519-1:2003 applies.

11 Equipotential bonding

Clause 11 of IEC 60519-1:2003 applies except as follows.

11.4.2

Replacement:

Earthing of one of the high voltage poles of the microwave generator is allowed.

If the high voltage power supply and the microwave generator are not in the same metal housing and have a common chassis, an additional high voltage cable, in addition to normal means for earthing, having the same class of insulation as for the high voltage cables, shall be mounted between the chassis of the high voltage power supply and the microwave generator chassis. The mounting point shall not be used for any other purpose.

12 Control circuits and control functions

Clause 12 of IEC 60519-1:2003 applies except as follows.

Additional subclauses:

12.101 Requirements for microwave interlocking devices

12.101.1 Means of access

The opening of a means of access of microwave heating equipment shall operate two microwave interlocks, designed for high security and long-term operation. These interlocks shall prohibit the operation of any microwave generator.

NOTE If not obvious by the main electrical circuit design, the operation of the microwave generator is verified by the leakage measurement according to Annex A.

The failure of any single electrical or mechanical component shall not cause all microwave interlocks on any means of access to be inoperative.

The failure of one of the two electromechanical microwave interlocks on the means of access to perform its intended function shall trigger an alarm and at the same time render the microwave heating equipment inoperative.

12.101.2 Maintenance doors and covers

The opening or removal of each maintenance door or cover shall operate at least one interlock, or be provided with a key lock, if the microwave exposure may exceed the value specified in Annex A with the maintenance door or cover removed.

12.101.3 Microwave absorbing means

In microwave heating equipment with means for absorbing microwave energy which require flow of a liquid, reduction of liquid flow at the output of any absorbing means shall operate at least one interlock, if the said reduction results in microwave leakage in excess of the limit specified in Annex A.

In microwave heating equipment with means for absorbing microwave energy without any dedicated cooling, the absorbing function shall not be impaired by excessive temperature rises in the absorber. This is tested under normal operation, and also under conditions of abnormal operation as specified in 6.1.2. The absorbing means shall remain securely in place and not be degraded.

13 Protection against thermal influences

Clause 13 of IEC 60519-1:2003 applies.

14 Risk of fire and danger of explosion

Clause 14 of IEC 60519-1:2003 applies except as follows.

Addition:

Microwave heating equipment shall be so designed, constructed and operated that risks of burns, fire, and explosions are minimised as far as practicable. In addition to the provisions of IEC 60519-1:2003, the following requirements shall be met when applicable:

Additional subclauses: