

INTERNATIONAL STANDARD

NORME INTERNATIONALE



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

**Sécurité dans les installations destinées au traitement électrothermique et
électromagnétique –**

**Partie 6: Exigences particulières pour les équipements de chauffage et de
traitement diélectriques à hautes fréquences et à hyperfréquences**



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CONTENTS

FOREWORD.....	4
INTRODUCTION.....	7
1 Scope.....	8
2 Normative references	9
3 Terms and definitions	9
3.1 General concepts.....	9
3.2 Equipment and state of equipment.....	11
3.3 Parts and accessories.....	13
4 Classification and subdivision of equipment and installations.....	13
4.1 Classification by processing frequency.....	13
5 Risk assessment	14
6 General provisions.....	14
7 Protection against hazards from electric shock	15
8 Protection against hazards from electric or magnetic fields.....	17
9 Protection against hazards from radiation.....	20
10 Protection against hazards from thermal influences.....	21
11 Protection against hazards from fire.....	21
12 Protection against hazards from fluids.....	22
13 Specific requirements for components and subassemblies.....	22
14 Control of the installation or equipment.....	22
15 Protection against mechanical hazards.....	23
16 Protection against hazards resulting from use	23
17 EMC.....	23
18 Verification and testing.....	23
19 Information for use	23
Annex A (normative) List of significant hazards.....	24
Annex B (normative) Limits to touch currents.....	25
Annex C (normative) Non coherent optical radiation – Limits and risk classes.....	26
Annex D (normative) Electric and magnetic fields	27
Annex E (normative) Surface temperature limits	28
Annex F (normative) EH, EPM and fire.....	29
Annex G (normative) Marking and warning.....	30
Annex H (informative) Guidelines on using this document.....	31
Annex I (informative) Connection with ISO 13577 (all parts).....	32
Annex J (informative) Requirements specific to the EU and associated countries.....	33
Annex AA (normative) Information for use.....	34
AA.1 General.....	34
AA.2 Labelling.....	34
Annex BB (normative) Measurements and evaluations of the high frequency emission and contact current.....	37
BB.1 General.....	37
BB.2 Conditions of equipment operation for measurements	37
BB.3 Evaluation of the HF field characteristics	37

BB.4	Electric, magnetic fields, and contact currents.....	38
BB.5	Limiting values, continuous energising of the processing frequency source.....	39
BB.6	Limiting values, intermittent energising of the processing frequency source	39
BB.7	Relaxation for processing frequencies up to 41 MHz	39
BB.8	Risk classes.....	40
BB.9	Instrumentation	40
Annex CC	(normative) Measurements and evaluations of the microwave emission	44
CC.1	Conditions for measurement	44
CC.2	Measurement details.....	44
CC.3	Risk classes.....	44
CC.4	Instrumentation	45
Annex DD	(informative) Rationales for the high frequency emission limits and measurements	49
DD.1	The biological effects of HF emissions from 3 MHz to 300 MHz.....	49
DD.2	Today's agreed limits for operator safety	49
DD.3	Differences between the concepts in the cited standards and this document.....	50
DD.4	Field behaviour	51
DD.5	Conclusions	60
Annex EE	(informative) Rationales for the microwave barrier and associated microwave leakage tests.....	62
EE.1	Standard measurement of microwave emission.....	62
EE.2	Microwave hazards – SAR basic restriction.....	63
EE.3	Microwave hazard evaluation – free space exposure method	63
EE.4	Microwave hazards from openings in cavities, and from exit and entrance ports	64
EE.5	Time averaging	65
EE.6	Conclusions and modifications of the standards for ovens with a cavity door	66
Bibliography	67
Figure AA.1	– Examples of warning sign and labels	35
Figure AA.2	– Labels at open HF applicators and handheld or open MW applicators.....	35
Figure BB.1	– Large HF barrier for a conveyorised heating equipment scenario.....	42
Figure BB.2	– Conditions for a HF plastic welding equipment.....	43
Figure CC.1	– Large barrier for conveyorised microwave heating equipment.....	46
Figure CC.2	– Small microwave access barrier for conveyorised microwave heating equipment.....	47
Figure CC.3	– Vertical-only MW barriers for conveyorised microwave heating equipment.....	48
Figure DD.1	– The overall complete scenario (left) with details	53
Figure DD.2	– Field maxima with linear scaling (six top images) and decibel scaling (six bottom images)	55
Figure DD.3	– Quiver plots of momentary total fields at the same time phase	56
Figure DD.4	– Power density patterns in the body-parts receiving the highest exposure values	57
Figure DD.5	– E field comparisons 30/100 MHz, and 100 MHz field polarisation	58
Figure DD.6	– SAR maxima at 100 MHz in the scenario with only the body present	59
Table 101	– Dimensional requirements for HF/MW barriers.....	21
Table DD.1	– Maximum power densities in circularly cylindrical muscle objects irradiated by 100 MHz plane waves with the E field parallel to the axis	60

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**SAFETY IN INSTALLATIONS FOR ELECTROHEATING
AND ELECTROMAGNETIC PROCESSING –****Part 6: Particular requirements for high frequency dielectric
and microwave heating and processing equipment**

FOREWORD

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IEC 60519-6 has been prepared by IEC technical committee 27: Industrial electroheating and electromagnetic processing. It is an International Standard.

This fourth edition cancels and replaces the third edition published in 2011.

This edition constitutes a technical revision.

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

- a) the structure has been redrafted according to the IEC 60519-1:2020;
- b) the scope and object have been redrafted;
- c) the terms/definitions, normative references and bibliography have been updated and completed;

- d) all requirements and content from IEC 60519-6:2011 which are included in IEC 60519-1:2020 were removed to avoid any duplication;
- e) inclusion of high frequency equipment which was previously covered by IEC 60519-9:2005 (withdrawn). This edition constitutes an extension to high frequency equipment.

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

Draft	Report on voting
27/1142/FDIS	27/1144/RVD

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

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

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

A list of all parts in the IEC 60519 series, published under the general title *Safety in installations for electroheating and electromagnetic processing*, can be found on the IEC website.

The clauses of this part 6 of the IEC 60519 series (called Particular Requirements) supplement or modify the corresponding clauses of IEC 60519-1:2020 (*General Requirements*), hereinafter called Part 1.

In this standard, the following print types are used:

- requirements and definitions: in roman type;
- NOTES: in smaller roman type;
- terms defined in Clause 3 in this document and in Part 1 are in **bold type**, from Clause 1.

This part of IEC 60519 is to be read in conjunction with Part 1. It supplements or modifies the corresponding clauses of Part 1. Where the text indicates a “modification” of, “addition” to or a “replacement” of the relevant provision of Part 1, these changes shall be made to the relevant text of Part 1. Where no change is necessary, the words “This clause of Part 1 is applicable” are used. When a particular subclause of Part 1 is not mentioned in this part, that subclause applies as far as is reasonable. When a particular subclause of Part 1 is not applicable, the word “void” is used.

Additional specific provisions to those in Part 1, given as individual clauses or subclauses, are numbered starting from 101.

NOTE 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.

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

- reconfirmed,
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INTRODUCTION

Some types of **electroheating equipment**, including the **workload**, can emit hazardous levels of infrared radiation. It has been agreed in the IEC Technical Committee 27 that IEC 60519-12 addresses these infrared radiation aspects for this document.

This document presumes that the **manufacturer** possesses sufficient knowledge in equipment design, manufacturing and documentation in accordance with good engineering practise, and that the installation or equipment is operated and maintained only by personnel consisting of **skilled or instructed persons**.

This document is intended to verify whether the installation or equipment meets the requirements of safety, by design, and numerical verification if carefully carried out, site acceptance tests, routine tests or inspection.

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SAFETY IN INSTALLATIONS FOR ELECTROHEATING AND ELECTROMAGNETIC PROCESSING –

Part 6: Particular requirements for high frequency dielectric and microwave heating and processing equipment

1 Scope

This clause of Part 1 is modified by the following regarding the areas of application.

Modification:

This part of IEC 60519 is applicable to equipment using high frequency or microwave energy alone or in combination with other kinds of energy for industrial heating and processing of materials. It is also applicable to **HF** and **MW generators** made available to **users** as separate units.

This part is applicable to equipment operating in the frequency range 3 MHz to 300 GHz, with the following limitations.

- This document applies to only high frequency **dielectric heating** and **processing** as defined in 3.1.103. It does not apply to induction heating, which it is possible to carry out in the lower part of the specified frequency band and is covered by IEC 60519-3, with magnetic field safety aspects addressed in IEC TS 62997:2017, the latter to be replaced by a technical report (TR) or by a revised technical specification (TS).
- The ISM centre frequencies for **dielectric heating** and **processing** of industrial interest are narrow bands about 6,78 MHz, 13,56 MHz, 27,12 MHz and 40,68 MHz. Different field **emission** measurement procedures and limiting values are applicable, depending on the **processing frequency** in the high frequency range 3 to 300 MHz. Specifications are in Annex BB.
- This document specifies limits for microwave **emission** only for the ISM frequencies between 800 MHz and 6 MHz, as specified in Annex CC. For other microwave frequencies the **basic restriction** and IEC 62311 apply.
- The foundations for compliance with **emission** values are the **basic restrictions**, referred to in the IEEE/ANSI C95.1:2019 and Directive 2013/35/EU. However, maximum **HF processing frequency** electric and magnetic field values are taken from the IEEE/ANSI C95.1:2019 standard, as indicated in Annex BB.
- This document is not applicable to:
 - appliances for household and similar use (covered by e.g. IEC 60335-2-25);
 - commercial use (covered by IEC 60335-2-90 and IEC 60335-2-110);
 - laboratory use (covered by IEC 61010-2-010);
 - medical high frequency equipment and accessories (covered by IEC 60601-2-2).

NOTE 101 Since high frequency and microwave tunnel ovens and also some other types of microwave and high frequency equipment are sometimes intended 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 are sometimes not in a final state from the perspective of the end user.

2 Normative references

This clause of Part 1 is applicable with the following addition.

Addition:

IEEE/ANSI C95.1:2019, *IEEE standard for safety levels with respect to human exposure to electric, magnetic, and electromagnetic fields, 0 Hz to 300 GHz*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60519-1 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

Additions:

3.1 General concepts

3.1.101

basic restrictions

BR

restrictions on *in situ* (i.e. internal) electric fields or specific absorption rates (SAR) or power densities with time and spatial averaging or integration, resulting from a part of or the whole body being subjected to an external alternating electric (E) field, magnetic (B) flux or electromagnetic field, and that are intended to be based directly on resulting established pathophysiological effects

Note 1 to entry: The term exposure is defined in 3.4.14 in Part 1. Other definitions are provided in Annex DD.2.1. There are no exposure requirements in this document since its definition does not consider any specific characteristics of the source and **accessible emission**, as in this document. See Note 3 to entry.

Note 2 to entry: **Basic restrictions** have a safety margin to harm.

Note 3 to entry: Sources of scientific and medical information on numerical values of limits for workers are e.g. IEEE, ICNIRP and EU; see the Bibliography. Another term for the **basic restrictions** is exposure limit values (ELV).

Note 4 to entry: Time factors of **specific absorption rates (SAR)** or power densities, i.e. energy absorption versus time and over which tissue volumes are necessary for establishing criteria.

[SOURCE: IEC TS 62997:2017, 3.1.2, modified, to be replaced by a technical report (TR) or by a revised technical specification (TS)]

3.1.102

contact current

induced current

current flowing into the body resulting from contact with a conductive object in an electric, magnetic or electromagnetic field

Note 1 to entry: The scientific definition of induced current in IEC 60050-121:1998, 121-11-29 is replaced here, but the definitions are consistent.

Note 2 to entry: A **touch current** flows through the body or body-parts between two defined contact areas as defined in e.g. Entry 3.4.6 in Part 1.

[SOURCE: IEC TR 63167:2018, 3.1]

3.1.103

dielectric heating and processing

electric treatment process in which the heat is generated in lossy dielectric or semiconducting **HF loads** in the frequency range 1 MHz to 300 MHz

Note 1 to entry: The addition of “lossy” is used in this context since the power absorption mechanism can be by dipolar relaxation and ionic or other conductivity phenomena.

Note 2 to entry: **Dielectric heating** and **processing** does not apply to metallic **HF loads**.

[SOURCE: IEC 60050-841:2004, 841-28-01, modified – The entry has been extended by adding “processing”, the definition has been completed by adding “lossy” and two notes have been added.]

3.1.104

electric nearfield

accessible emission of an electric field at a distance, characterised by fulfilling the criterion of **dielectric heating and processing**

Note 1 to entry: The practical consequence of the definition is that the **accessible emission** of the electric nearfield energy (proportional to $\epsilon_0|E|^2$) is approximately equal to or higher than the magnetic nearfield energy (proportional to $\mu_0|H|^2$) in the same locations, where ϵ_0 is the electric constant and μ_0 the magnetic constant. Due to the relative phase of these fields, their coupling to body-parts is very different than from a propagating electromagnetic field.

3.1.105

electromagnetic emission

phenomenon by which electric, magnetic or electromagnetic energy is available near a source

Note 1 to entry: The **emission** characteristics and equipment-related precautionary measures are used instead of operator exposure limits in this document, and are intended to result in a tolerable risk as defined in ISO/IEC Guide 51. <https://standards.itec.ai/catalog/standards/sist/3ba1b2ac-deb7-4d5b-90ad-9b2ace69691b/iec-60519-6-2022>

Note 2 to entry: The source data used in this document is typically based on field properties of the **accessible emission**, but high frequency fields are also characterised/limited by the particular conditions for **dielectric heating and processing**.

Note 3 to entry: The energy is basically reactive where body-parts are present, i.e. non-radiating (evanescent).

[SOURCE: IEC 60050-161:1990, 161-01-08, modified – The definition has been modified by replacing the words “electromagnetic energy emanates from a source” by “electric, magnetic or electromagnetic energy is available near a source” and notes to entry have been added.]

3.1.106

HF/MW transparency

property of a material having negligible absorption and reflection of high frequency or microwave fields

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

[SOURCE: IEC 60050-841:2004, 841-29-14, modified – In the definition, the word “microwaves” has been replaced by “high frequency or microwave fields”.]

3.1.107**prospective primary capacitive current area**

part of the body in its most onerous position facing the live source

[SOURCE: IEC TS 62996:2017, 3.7, to be replaced by a technical report (TR) or by a revised technical specification (TS)]

3.1.108**secondary contact area**

live part or ground, with or without protective insulation, through which the current flows when the primary contact area is being contacted or touched, or through the **prospective primary capacitive current area**

[SOURCE: IEC TS 62996:2017, 3.10, to be replaced by a technical report (TR) or by a revised technical specification (TS)]

3.1.109**spark discharge**

transfer of current across an air gap prior to making contact with another conductive object at a different potential

[SOURCE: IEC TR 63167:2018, 3.6]

3.1.110**reference surface**

fictitious surface in the vicinity of mainly the **entrance and exit ports**, located as a consequence of **HF/MW leakage** measurements of **accessible emission**

Note 1 to entry: See 9.1.1.103 for the practical specifications.

3.1.111**scenario**

in numerical modelling, all relevant geometrical parts/components/body-parts, locations and dimensions, all complex permittivities, boundary conditions, source characteristics, excitation and operating frequency or frequency interval

3.2 Equipment and state of equipment**3.2.101****accessible <HF/MW> emission****HF/MW leakage**

electromagnetic, electric or magnetic field existing near the equipment where practically relevant measurement results related to **induced electric shock** or body-part SAR are considered possible

Note 1 to entry: Measurements of the field characteristics very close to a **processing frequency** source or a mechanically accessible part of the equipment are considered unreliable with regard to the possible specific absorption rate (SAR) in a body-part located there. As a consequence, minimum distances between the field measurement probe and mechanically accessible parts are to be defined, as is done in 9.1.1.103.

[SOURCE: IEC 60519-1:2020, 3.4.15, modified by addition of the necessity of the emission to be measurable]

3.2.102**cover**

structural feature of any part of the **HF/MW 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.

3.2.103
entrance port
exit port

openings in the **HF/MW enclosure** through which the **HF/MW load** moves

3.2.104
HF applicator

device comprising the heating capacitive device or work electrodes with their fixing and positioning systems, impedance matching circuits (if not situated in the generator assembly) and, where necessary, protective and screening devices, means for transport, supply and ventilation

3.2.105
HF enclosure
MW enclosure

enclosure intended to confine the electromagnetic, electric or magnetic energy to a defined region

Note 1 to entry: Examples are a **microwave cavity**, door seals and waveguides.

Note 2 to entry: **HF/MW barriers** mounted outside the **HF/MW enclosure** are not considered to be a part of it.

[SOURCE: IEC 60050-841:2004, 841-29-20, modified by extension to lower-frequency fields]

3.2.106
high frequency generator
HF generator

source used to produce electromagnetic energy in the **processing frequency** range from 3 MHz to 300 MHz

3.2.107
HF/MW interlock

interlock that prevents unacceptably high **HF/MW emission**

3.2.108

HF/MW load

objects in the treatment region of the **HF/MW applicator**

Note 1 to entry: This includes the **workload** as well as an intermediate electromagnetic ionised gas (plasma), and any containers, as well as **test loads** for determination of **HF/MW generator** characteristics.

[SOURCE: IEC 60050-841:2004, 841-29-12, modified by extension to lower-frequency fields]

3.2.109
MW applicator

structure which applies the electromagnetic energy to the **MW load**

EXAMPLE A **microwave cavity**, a plasma source, or a **handheld applicator**

[SOURCE: IEC 60050-841:2004, 841-29-11, modified by addition of examples]

3.2.110
microwave cavity

space enclosed by inner metal walls and a door or an access opening and in which the **micro-wave load** is placed

[SOURCE: IEC 60050-841:2004, 841-29-19, modified by use of the term microwave load]

3.2.111 microwave generator MW generator

source used to produce electromagnetic energy in the **processing frequency** range from 300 MHz to 300 GHz

3.3 Parts and accessories

3.3.101 HF/MW barrier

barrier which is **HF/MW transparent** and does not influence the HF/MW field

Note 1 to entry: **HF/MW barriers** may be fixed to the equipment or not; in either case they are considered to be a part of the installation.

Note 2 to entry: Devices such as an array of metal chains or hinged metal plates at **entrance and exit ports** intended to reduce **HF/MW leakage** are not considered **HF/MW barriers**.

Note 3 to entry: The **transparency** also applies to **guards**.

3.3.102 HF screen

screen that, when removed, significantly increases the **HF emission** in the region which it is intended to protect

Note 1 to entry: **HF screens** are reflective or absorptive, or both.

Note 2 to entry: **HF screens** may be fixed to the equipment or not; in either case they are considered to be a part of the installation.

Note 3 to entry: Devices such as hinged metal plates at **entrance and exit ports** intended to reduce **HF emission** are considered to be **HF screens**.

Note 4 to entry: The non-**transparency** also applies to **obstacles**.

3.3.103 maintenance door

all structural features of any part of the MW/HF equipment which can be opened or removed without the use of a tool to provide access to locations other than the **HF/MW applicator** or **microwave cavity**

3.3.104 test load

artificial power-absorbing device used for testing **HF/MW generators** with similar equivalent impedance to the actual **HF/MW load** for which the equipment is designed, to allow the output power to be applied under **normal operation** in the absence of the actual load

4 Classification and subdivision of equipment and installations

This clause of Part 1 is applicable with the following.

4.1 Classification by processing frequency

Modifications:

4.1.101 High frequency in this document means rated **processing frequencies** between 3 MHz and 300 MHz, and microwave means **processing frequencies** which are higher than 300 MHz.

NOTE **Dielectric heating and processing** frequencies less than 3 MHz are not considered industrially feasible.