IEC 62311

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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Assessment of electronic and electrical equipment related to human exposure restrictions for electromagnetic fields (0 Hz – 300 GHz)

Evaluation des équipements électroniques et électriques en relation avec les restrictions d'exposition humaine aux champs électromagnétiques (0 Hz – 300 GHz)

IEC 62311:2007

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ASSESSMENT OF ELECTRONIC AND ELECTRICAL EQUIPMENT RELATED TO HUMAN EXPOSURE RESTRICTIONS FOR ELECTROMAGNETIC FIELDS (0 Hz – 300 GHz)

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International Standard IEC 62311 has been prepared by IEC technical committee 106: Methods for the assessment of electric, magnetic and electromagnetic fields associated with human exposure.

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

FDIS	Report on voting
106/129/FDIS	106/134/RVD

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 committee has decided that the contents of this publication will remain unchanged until the maintenance result 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- withdrawn;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.

ASSESSMENT OF ELECTRONIC AND ELECTRICAL EQUIPMENT RELATED TO HUMAN EXPOSURE RESTRICTIONS FOR ELECTROMAGNETIC FIELDS (0 Hz – 300 GHz)

1 Scope and object

This International Standard applies to electronic and electrical equipment for which no dedicated product- or product family standard regarding human exposure to electromagnetic fields applies.

The frequency range covered is 0 Hz to 300 GHz.

The object of this generic standard is to provide assessment methods and criteria to evaluate such equipment against basic restrictions or reference levels on exposure of the general public related to electric, magnetic and electromagnetic fields and induced and contact current.

NOTE This standard is intended to cover both intentional and non-intentional radiators. If the equipment complies with the requirements in another relevant standard, e.g. EN 50371 covering low power equipment, then the requirements of this standard (IEC 62311) are considered to be met and the application of this standard to that equipment is not necessary. See also Clause 7.2.

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 60050-161, *International Electrotechnical Vocabulary – Chapter 161: Electromagnetic compatibility*

3 Terms and definitions

For the purposes of this document, the terms and definitions contained in IEC 60050-161 as well as the following terms and definitions apply.

3.1
averaging time
t_{avg}
appropriate time over which exposure is averaged for purposes of determining compliance

3.2
basic restriction
maximum exposure level that should not be exceeded under any conditions

NOTE Examples of basic restrictions can be found in Annex II of the Council Recommendation 1999/519/EC [6][1), ICNIRP Guidelines [1] IEEE Std C95.6™ [2] and IEEE Std C95.1™ [3].

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1) Figures in square brackets refer to the Bibliography.

3.3
contact current
current flowing into the body resulting from contact with a conductive object in an electromagnetic field. This is the localised current flow into the body (usually the hand, for a light brushing contact)

3.4
current density
J
current per unit cross-sectional area flowing inside the human body as a result of exposure to electromagnetic fields

3.5
duty factor
duty cycle
ratio of pulse duration to the pulse period of a periodic pulse train. Also, a measure of the temporal transmission characteristic of an intermittently transmitting RF source such as a paging antenna by dividing average transmission duration by the average period for transmissions. A duty factor of 1,0 corresponds to continuous operation

3.6
electric field strength
E
magnitude of a field vector at a point that represents the force (F) on an infinitely small charge (q) divided by the charge

$$E = \frac{F}{q}$$

3.7
equipment under test
EUT
an electrical or electronic apparatus that is tested for compliance with exposure limits

3.8
exposure
exposure occurs whenever and wherever a person is subjected to electric, magnetic or electromagnetic fields or to contact current other than those originating from physiological processes in the body and other natural phenomena

3.9
exposure level
value of the quantity used to assess exposure

NOTE This may be an induced current density, *SAR*, power density, electric or magnetic field strength, a limb current or a contact current.

3.10
exposure limit
value of an electric, magnetic or electromagnetic field derived from the basic restrictions using worst-case assumption about exposure. If the exposure limit is not exceeded, then the basic restrictions will never be exceeded

3.11
exposure, direct effect of
result of a direct interaction in the exposed human body from exposure to electromagnetic fields

3.12
exposure, indirect effect of
result of a secondary interaction between the exposed human body and an electromagnetic field, often used to describe a contact current, shock or burn arising from contact with a conductive object

3.13
exposure, partial-body
localised exposure of part of the body, producing a corresponding localised *SAR* or induced current density, as distinct from a whole-body exposure

3.14
exposure, whole-body
exposure of the whole body (or the torso when induced current density is considered)

3.15
induced current
current induced inside the body as a result of exposure to electromagnetic fields

3.16
limb current
current flowing in an arm or a leg, either as a result of a contact current or else induced by an external field

3.17
magnetic field strength
H
magnitude of a field vector in a point that results in a force (F) on a charge (q) moving with velocity (v)

$$F = q\left(v \times \mu H\right)$$

(or magnetic flux density divided by permeability of the medium, see 3.18 "magnetic flux density")

3.18
magnetic flux density
B
magnitude of a field vector that is equal to the magnetic field H multiplied by the permeability (μ) of the medium

$$B = \mu H$$

3.19
multiple frequency fields
superposition of two or more electromagnetic fields of differing frequency.

NOTE These may be from different sources within a device, e.g., the magnetron and the transformer of a microwave oven, or they may be harmonics in the field of a nominally single frequency source such as a transformer

3.20
power density
S
power per unit area normal to the direction of electromagnetic wave propagation. For plane waves the power density (S), electric field strength (E) and magnetic field strength (H) are related by the impedance of free space, i.e., 377 Ω

$$S = \frac{E^2}{377} = 377\ H^2 = EH$$

NOTE 1 Although many survey instruments indicate power density units, the actual quantities measured are E or H or the square of those quantities.

E and H are expressed in units of V/m and A/m, respectively, and S in the unit of W/m^2.

NOTE 2 It should be noted that the value of 377 Ω is only valid for free space, far field measurement conditions.

3.21
power density, average (temporal)
instantaneous power density integrated over a source repetition period. This averaging is not to be confused with the measurement averaging time

3.22
power density, plane-wave equivalent
commonly used term associated with any electromagnetic wave, equal in magnitude to the power density of a plane wave having the same electric (E) or magnetic (H) field strength as the measured field

3.23
reference levels
levels of field strength or power density derived from the basic restrictions using worst-case assumptions about exposure. If the reference levels are met, then the basic restrictions will be complied with, but if the reference levels are exceeded, that does not necessarily mean that the basic restrictions will not be met

3.24
root-mean-square
r.m.s.
the effective value or the value associated with joule heating, of a periodic electromagnetic wave. The r.m.s. value is obtained by taking the square root of the mean of the squared value of a function

$$F = \sqrt{\frac{1}{T}\int_{-\frac{T}{2}}^{\frac{T}{2}}\left(F(t)\cdot F(t)^{*}\,dt\right)} \quad \text{(expression in time domain)}$$

$$X = \sqrt{\sum_{1}^{n}(X_{\text{n}})^2} \quad \text{(expression in frequency domain)}$$

NOTE Although many survey instruments in the high frequency range indicate r.m.s., the actual quantity measured is root-sum-square (rss) (equivalent field strength).

3.25
root-sum-square
rss
the value rss is obtained from three individual r.m.s. field strength values, measured in three orthogonal directions, combined disregarding the phases.

$$X = \sqrt{X_{\text{x}}^2 + X_{\text{y}}^2 + X_{\text{z}}^2}$$

3.26
specific absorption
SA
energy absorbed per unit mass of biological tissue, expressed in joule per kilogram (J/kg); specific energy absorption is the time integral of specific energy absorption rate

3.27
specific absorption rate
SAR
power absorbed by (dissipated in) an incremental mass contained in a volume element of biological tissue when exposure to an electromagnetic field occurs. *SAR* is expressed in the unit watt per kilogram (W/kg). *SAR* is used as a measure of whole-body exposure as well as localised exposure

3.28 exposure assessment
for purposes of this standard the term exposure assessment means conformity assessment with respect to applicable exposure limit(s).

4 Compliance criteria

Reference levels (e.g., maximum permissible exposure values, investigation levels) for public exposure to electric, magnetic and electromagnetic fields are derived from the basic restrictions using realistic worst-case assumptions about exposure. If the reference levels are met, then the basic restrictions will also be met; if the reference levels are exceeded, that does not necessarily mean that the basic restrictions are exceeded. In some situations, it may be possible to show compliance with the basic restrictions directly. It may also be possible to derive compliance criteria that allow a simple measurement or calculation to demonstrate compliance with the basic restriction. Often these compliance criteria can be derived using realistic assumptions about conditions under which exposures from a device may occur, rather than the conservative assumptions that are the basis for the reference levels.

NOTE The limit is the basic restriction.

If the technology in the equipment is not capable of producing at the normal user position, an *E*-field, *H*-field or contact current at levels higher than the reference levels, e.g. there are no conductive touchable parts or the conductive touchable parts are permanently connected to ground, then the equipment is deemed to comply with the requirements in this standard in respect of that *E*-field, *H*-field or contact current without further assessment.

5 Assessment methods

One or more of the examples of assessment methods in 7.2 may be used.

The assessments should be made according to an existing basic standard. If the assessment method in the basic standard is not fully applicable then deviations are allowed as long as

– a description of the assessment method used is given in the assessment report;

– an evaluation of the total uncertainty is given in the assessment report.

For transmitters intended for use with external antennas at least one typical combination of transmitter and antenna shall be assessed. The technical specification (under far field conditions) of this antenna shall be documented in detail such that the boundary where the basic restrictions are met can be identified, e.g., by documented radiation patterns.

For non-radio transmitting apparatus, the compliance assessment to emissions of *E* or *H* field has to be made according to the highest internal frequency used within the apparatus under analysis or at which the apparatus operates with the following criteria:

– if the highest internal frequency of the apparatus is less than 100 MHz, the assessments shall only be made up to 1 GHz;
– if the highest internal frequency of the apparatus is between 100 MHz and 400 MHz, the assessment shall only be made up to 2 GHz;
– if the highest internal frequency of the apparatus is between 400 MHz and 1 GHz, the assessment shall only be made up to 5 GHz.

If the highest internal frequency of the apparatus is above 1 GHz, the measurement shall be made up to 5 times the highest frequency.

6 Evaluation of compliance to limits

The apparatus is deemed to fulfill the requirements of this standard if the measured values are less than or equal to the limit and if the actual assessment uncertainty is less than the maximum measurement uncertainty specified for the applied assessment method(s). The assessment uncertainty of assessment method shall be determined by calculating the expanded uncertainty using a confidence interval of 95 %.

Generally, a relative uncertainty of 30 % is used for a number of EMF assessment methods. Therefore this level of relative uncertainty is used as a default maximum in this generic standard.

If the relative uncertainty is less than 30 %, then the measured value L_m shall be compared directly with the applicable limit L_{lim} for evaluation of compliance.

If the relative uncertainty is larger than 30 %, then the actual uncertainty shall be included in the evaluation of compliance with the limit as follows.

If the actual assessment uncertainty is larger than the specified maximum allowed uncertainty value and if it is also larger than the maximum default uncertainty value of 30 %, then a penalty value shall be added to the assessment result before comparison with the limit. Conversely, one can also reduce the applicable limit L_{lim} with the same penalty value, and compare the actual measured L_m value with the reduced limit. The right-hand side of Equation 1 shows how the limit L_{lim} is reduced in case the actual relative uncertainty is larger then 30 %.

NOTE The uncertainty of EMF assessment methods is generally given in %. If the uncertainty is stated in non-linear units e.g. in dBs, then this value shall be converted into percentage (%) first.

Equation 1 shall be used to determine whether the measured value L_m complies with reduced limit if the actual measurement uncertainty of the applicable assessment method is 30 % or more.

$$L_m \leq \left(\frac{1}{0{,}7 + \frac{U(L_m)}{L_m}} \right) L_{lim} \qquad (1)$$

where

L_m is the measured value;

L_{lim} is the exposure limit;

$U(L_m)$ is the absolute expanded uncertainty.

EXAMPLE:

Suppose the relative uncertainty of a certain EMF assessment method is 55 %. Then

$$\frac{U(L_m)}{L_m} = 0{,}55$$

Using Equation (1), the acceptance criterion for the measured value is then:

$$L_m \le \left(\frac{1}{0{,}7 + \frac{U(L_m)}{L_m}} \right) L_{lim} = \left(\frac{1}{0{,}7 + 0{,}55} \right) L_{lim} = \frac{1}{1{,}25} L_{lim} = 0{,}8\ L_{lim}$$

The uncertainty penalty (the amount of reduction of the limit) is then:

$$U_{pen} = L_{lim} - 0{,}8\,L_{lim} = 0{,}2\ \ L_{lim}$$

The uncertainty values specified for each EMF assessment method are the maximum allowed uncertainties. If the uncertainty value is not specified, then a default value of 30 % shall be used.

NOTE Guidance on the uncertainty can be found in ANSI NCSL Z540-2 [8]: US guide to the expression of uncertainty in measurement and in the ISO/IEC Guide on Measurement Uncertainty [9].

7 Applicability of compliance assessment methods

7.1 General

An analysis can be made to investigate which parts emit EMF. A description of the several parts of an equipment is recommended in order to determine what parts are emitting EMF. Table 1 gives the characteristics and parameters of the equipment to be considered. Table 2 gives a list of possible assessment methods.