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High-frequency dielectric heating installations - Test methods for the determination of power output

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FOREWORD

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This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 61308:2005. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

IEC 61308 has been prepared by IEC technical committee 27: Industrial electroheating and electromagnetic processing. It is an International Standard.

This third edition cancels and replaces the second edition published in 2005. This edition constitutes a technical revision.

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

a) adaptation and alignment to the principles in more recent editions of IEC 60519-1 and IEC 60519-6;
b) more detailed descriptions of, in particular, the calorimetric load test and output power evaluation for dielectic plastic welders.

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

Draft	Report on voting
27/1244/FDIS	27/1248/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/publications.

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

– reconfirmed,
– withdrawn, or
– revised.

1 Scope ~~and object~~

~~This International Standard is applicable to industrial high-frequency dielectric heating installations used for the purpose of thermal applications such as melting, drying, welding, insect extermination, and gluing of partially conductive or non-conductive materials such as plastics, wood, rubber, textiles, glass, ceramic, paper, bamboo or foodstuffs, in both normal and protective atmospheres, using, for example, inert gases or vacuum.~~

~~This standard relates to high-frequency dielectric heating installations with nominal dielectric heating frequency in the range from 1 MHz to 300 MHz with rated useful output power greater than 50 W.~~

~~The main purpose of this standard is to assist in compliance with the requirements set out in 6.4 of IEC 60519-9 when testing electroheating power sources. It is not primarily intended as a means of representing a potential high-frequency heating application for the requirement of the user. Due to the large variety of dielectric heating applications, any output power value obtained as a result of these tests should not always be taken as representing the power that can be dissipated in a particular dielectric heating installation, but, in certain instances, the output power value could be used as an indication of performance.~~

~~The power required to heat a charge is dependent, for example, on the type of material heated, the temperature of heating and ambient moisture and on the construction of the electrode system.~~

~~NOTE Heating a charge with dielectric parameters deeply changing in time and/or temperature the value of the output power obtained with the actual charge may be different from that obtained in standard test conditions.~~

~~For equipment working outside the ITU-designated bands, the frequency of the generator follows the resonant frequency of the output circuit, thus the output power can remain fairly stable during the work cycle, even with hand tuning of the output circuit. Therefore, according to this standard, the test well represents the actual output power in practical work conditions.~~

~~For equipment working in ITU-designated bands, the frequency of the generator remains stable, but the resonant frequency of the output circuit varies with the change of dielectric parameters of the load. Therefore, the value of the mean output power in the work cycle can be much lower than the value obtained in the test conditions. This value depends on the time response of the eventual automatic tuning system.~~

This document specifies test methods for the determination of useful high frequency power output in equipment for industrial heating and processing of materials. It is in particular applicable to HF generators made available to users as separate units.

This document is basically applicable to equipment operating in the frequency range 100 kHz to 300 MHz, as defined in IEC 60519-1, with the following limitations.

– This document does not apply to induction heating, which it is possible to carry out in the lower part of the specified frequency band.
– 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.
– This document is not applicable to:
  - appliances for household and similar use;
  - commercial use;
  - laboratory use;
  - medical high frequency equipment.

For equipment working in designated ISM bands, it is a legal requirement that the frequency remains within the ISM bands according to CISPR 11, but the resonant frequency of the circuit varies with the change of dielectric parameters of the load. Therefore, the value of the mean output power in the work cycle can be much lower than the value obtained under the test conditions. This value depends upon the response of the tuning system.

NOTE 1 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;

– 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.

NOTE 2 Heating a workload with dielectric parameters which change significantly in time and/or with temperature, the value of the output power obtained with the actual charge can be different from that obtained with the test load specified in this document.

This document relates to equipment normally operating under continuous rated conditions.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 (IEV) - Part 841: Industrial electroheat*

IEC 60519-1, *Safety in installations for electroheating and electromagnetic processing - Part 1: General requirements*

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

~~IEC 60519-9, *Safety in electroheat installations – Part 9: Particular requirements for high - frequency dielectric heating installations*~~

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-841 ~~and IEC 60519-9~~, IEC 60519-1, IEC 60519-6 and the following apply.

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

– IEC Electropedia: available at https://www.electropedia.org/

– ISO Online browsing platform: available at https://www.iso.org/obp

3.1
type A equipment
<high frequency> equipment with ~~a dielectric heating~~ the high frequency converter or generator independent of, or separable from, the applicator to which the high-frequency power is provided~~, for example, by a coaxial feeder~~

Note 1 to entry: The separation is by a coaxial line feeder or alternative means.

3.2
type B equipment
<high frequency> equipment with ~~a dielectric heating~~ the high frequency converter or generator directly coupled to the applicator, for example, ~~generator~~ built into the plastic welding press, or mounted on a tunnel oven

Note 1 to entry: In some cases, equipment with the dielectric heating generator directly connected to the heating chamber and inseparable from it can be treated as type A equipment.

3.3
useful output power
<type A equipment> maximum power as measured in a test load ~~described in this standard~~

~~NOTE In this type, the output terminals of the generator are accessible, or the heating capacitor allows the use of the wet-sand test. In certain cases, the parts of the gluing or welding press can be disconnected, allowing access to the output terminals. The useful output power will be equal to, or greater than, the rated useful output power.~~

3.4
useful output power
<type B equipment> high frequency power developed in the normal load

~~oscillating power calculated on the basis of measured values of voltages and currents~~

~~NOTE The design of such equipment does not allow the connection of a test load. Therefore, only evaluated useful output power can be specified (see 5.7). For a particular kind of equipment, the output, for example, the number of pieces heated per hour, may be given, or the output power can be evaluated by the plastic welding test electrode. The useful output power will be equal to, or greater than, the rated useful output power.~~

3.5
plastic welding test electrode
cutting-edge welding electrode which typically consists of straight parallel parts separated by 20 mm, 2 mm broad, 20 mm high and as long as practically possible for the press used

4 Test loads

4.1 General

There are four different types of useful output power test loads used in high-frequency dielectric heating installations. Only the main ones are outlined here. Specific constructions shall conform to known engineering techniques. The test loads should be constructed so as to represent the characteristics (e.g. dimensions, impedance) of the ~~working~~ normal load as closely as practically possible.

The ~~calorimeter~~ calorimetric load, lamp load and resistive load allow the measurement of the output power of the dielectric heating generator. The wet-sand load allows the measurement of the useful output power ~~of the dielectric heating installation (as defined in IEC 60519-9)~~.

For plastic welders, the test with the electrode defined in 3.5 allows the evaluation of the output power of the ~~dielectric heating~~ installation.

4.2 ~~Calorimeter~~Calorimetric load

~~A calorimeter load is used for measuring the useful output power when the load is assumed to be a combination of capacitance and resistance and for cases where the measured power is about 1 kW or greater.~~

A calorimetric load is a substitute load for measuring output power to the normal load having similar impedance to it. It is used for cases where the measured power is about 1 kW or greater.

4.3 Lamp load

~~The lamp load is used to measure useful output power of up to about 1 kW.~~ A load consisting of incandescent lamps is used according to 3.3 up to about 1 kW.The matching of the load is accomplished by the selection of single-lamp power as well as by the connection of several lamps in parallel or in series.

4.4 Matched resistive load

A matched resistive load can be used for applications where the load can be connected to the high-frequency output terminals.

4.5 Wet-sand load

~~The load, which consists of a charge of wet sand placed in the heating capacitor, can be used for some applications where the high-frequency output terminals of the generator are not accessible.~~

This load consists of a charge of wet sand of similar impedance to the normal load. It is suitable for some type B equipment and shall then be placed in the applicator in the same location as the normal load.

5 Description of tests

5.1 General

~~Values of electromagnetic fields in places accessible to the personnel shall conform to national and/or international safety regulations.~~

High-frequency electromagnetic fields should not affect measuring devices.

For all listed calorimetric methods, ~~care shall be taken~~ ensure that the outlet temperature is measured as close as possible to the load in order to reduce heat losses.

5.2 ~~Calorimeter~~Calorimetric load method

Typical examples are shown in Figure 1 and Figure 2, but variations of these designs are acceptable. The measuring element is composed of low dielectric loss glass or ~~a low power-loss~~ HF-transparent material and comprises two electrodes manufactured from a non-magnetic material such as copper or aluminium.

The generator output terminals are connected to the two electrodes, with water serving as the power-absorbing medium flows through the charge. The electrode spacing ~~may~~ can be adjustable for load-matching purposes. To achieve the correct impedance matching between the generator and the load, it ~~may be~~ is necessary to use the equipment's tuning circuit, in order to obtain the ~~required~~ correct output power.

For class A equipment, the tuning circuit should be designed to minimise heat losses.

For class B equipment, the tuning circuit should be the same circuit as used during the intended operation in order to achieve the correct impedance matching between the generator and the load. It is typically necessary to retune to obtain the correct output power.

The procedure for testing the system is the following:

a) run the system with the normal load at the required power;

b) remove the normal load;

c) replace with the calorimetric load;

d) without significant adjustment to the tuning, or other controls (e.g. inductor/capacitor values, electrode plate position etc.), adjust the impedance of the calorimetric load, to give the same running conditions that were obtained for the actual load (without changing the tuning settings significantly).