IEC/TS 60519-5

Edition 1.0 2008-03

TECHNICAL SPECIFICATION

SPÉCIFICATION TECHNIQUE

Safety in electroheat installations –
Part 5: Specifications for safety in plasma installations

Sécurité dans les installations électrothermiques –
Partie 5: Spécifications pour la sécurité dans les installations plasma

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

PRICE CODE
CODE PRIX

Q

ICS 25.180.10

ISBN 2-8318-9635-5

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FOREWORD

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Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC 60519-5 which is a technical specification, has been prepared by IEC technical committee 27: Industrial electroheating equipment.

This first edition of TS cancels and replaces the first edition of International Standard IEC 60519-5 published in 1980. It constitutes a technical revision.

The significant changes with respect to the previous edition are as follows:

– the previous edition focused on arc heating means and on spraying applications – this TS applies to all means of production of thermal plasma, i.e. arc and induction heating, and to the equipment directly coupled to these means. Applications include both the spraying plasma process, as well as the heating and/or thermochemical plasma treatment;
– new technical issues, such as those referring to the protection against electromagnetic emissions have been introduced;
– IEC 60519-1:2003 has been taken into account;
– definitions have been brought into line with the second edition of IEC 60050-841.

This technical specification is to be used in conjunction with IEC 60519-1:2003.

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
27/579/DTS	27/604A/RVC

Full information on the voting for the approval of this technical specification 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 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

- transformed into an International standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

SAFETY IN ELECTROHEAT INSTALLATIONS –

Part 5: Specifications for safety in plasma installations

1 Scope and object

This Technical Specification specifies safety requirements applicable to

a) thermal plasma torch systems:
   – arc plasma systems,
   – inductive plasma systems;
b) installations using plasma torch systems:
   – spraying equipment,
   – solid, liquid and gaseous charge heating and thermochemical treatment equipment.

For both plasma torch systems and installations using plasma torch systems, this specification determines safety requirements for all components, including the electrical equipment, the cooling circuits, the gas supply circuits, the furnace or reactor and more generally, all other equipment associated with the use of the furnace or reactor.

Safety and construction requirements for plasma torches for welding, cutting and allied processes are specified in IEC 60974-7.

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

IEC/TS 60680, *Test methods of plasma equipment for electroheat and electrochemical applications*

CISPR 11, *Industrial, scientific and medical (ISM) radio-frequency equipment – Electromagnetic disturbance characteristics – Limits and methods of measurement*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-841, IEC 60519-1 and IEC/TS 60680 apply.

4 Safety requirements in thermal plasma systems – design and installation features

4.1 Arc plasma torch systems

4.1.1 General requirements

See IEC 60519-1.

4.1.2 Electric circuit

See IEC 60519-1, Clause 6. In addition, 6.4.1 of IEC 60519-1 applies to the complete installation.

4.1.3 Direct current arc power supply

The following specific requirements apply to systems with d.c. arc power supply.

4.1.3.1 Power supply grounding

One pole (positive or negative, depending on the torch polarity), on the d.c. side of the arc power supply, shall be grounded using a separated earth from the main one of the system, so as to avoid possible leakage currents towards electrical circuits such as those used for the torch control.

4.1.3.2 Connection of the power supply to the torch

When the torch is off, the cables on the d.c. side shall be grounded through an earth grounding switch, so as to safely handle the torch.

A specific procedure shall be performed before the arc ignition, through a manual locking/unlocking device (generally operated with safety keys), authorizing in particular the main breaker to be online and the earth grounding switch to be in the off position. Moreover, a final clearance key may be used by the operator to start the ignition sequence. This procedure shall meet the regulations in force in the country where the equipment is to be installed.

4.1.4 Torch sockets, plugs and connection cables

See IEC 60519-1, Clause 8.

4.1.5 Torch

An arc plasma torch of any design has the following characteristic features: a high temperature gas, high voltage (in general) and liquid cooling (generally water). Consequently, the design and construction shall satisfy the following criteria for safe operation:

a) electrical features:
   - permanent electrical contact, during operation, between parts designed to be at the same voltage, including the clamping of electrodes and pieces to be earth grounded, to avoid overheating;
   - for a high voltage torch, automatic shut down of the torch in case the leakage current through the torch body excesses 10 mA;
   - permanent electrical insulation between pieces to be brought to different voltages (and specifically between the electrodes), so that no unintended breakdown can occur under normal operating conditions;

b) cooling liquid features:

– cooling liquid resistivity and torch circuit designed to maintain, during operation, the required insulation between pieces to be brought to different voltages, and specifically the electrodes;

– in case of electrode break through (accidental or normal wear), the phenomenon shall remain under control firstly through the electrode material and/or design, secondly by its detection to shut down the torch.

4.1.6 Cooling circuit

The following specific requirements apply to the cooling utilities:

a) mechanical features:

– the cooling liquid hoses of the torch, fixed or hand operated, shall have a sufficient length, flexibility and appropriate radius of curvature (if any), so as to be facing the stresses generated by the cooling liquid high pressure and to allow handling of the particular hand operated torch;

– taking into account the high pressure necessary to obtain the specified mass flow rate in the hoses, their mechanical strength shall not be appreciably affected by accidental or steady state exposure to hot particles (hot material from a furnace) or thermal heating from the torch itself or from hot material coming out from the process;

– if the direction of the cooling liquid flow is important, it shall be indicated by arrows and/or colour codes on the connecting fittings of the torch and hoses. Non-interchangeable couplers shall be used;

– the torch cooling liquid hoses, pipes and fittings shall remain liquid tight in the event of liquid hammer or blocking during operation at the specified mass flow rate, taking into account also the effects of heat on the hoses, also possibly due to radiation and ultra violet radiation;

– flexing at the coupling of the cooling liquid inlets and outlets to the torch shall be minimized as far as possible at the torch body and the couplings be provided at least with a basic insulation to reduce the possibility of electrical breakdown within the torch body;

b) electrical features:

– for the high-voltage torch, the hoses shall be made of insulated material, with length defined to limit the leakage current to a value below 10 mA;

– the torch shall be electrically shut down when the cooling circuit is disconnected or when the flow rate is below that specified;

– the operator shall have access to the cooling circuit control and monitoring devices, to be able to read their indications and take necessary steps when required.

4.1.7 Gas circuit

The following specific requirements apply to the gas utilities:

a) general features:

– safety rules for the use of industrial gas in high pressure tanks, taking account of the work regulations in force in the country where the equipment is to be installed;

b) mechanical features:

– the gas hoses of installations, fixed or hand operated, shall have a sufficient length, flexibility and appropriate radius of curvature (if any), so as to sustain the constraints generated by the gas high pressure and to allow handling in the case of hand-operated torch;

– the gas admission hose(s) shall be so designed as to withstand the pressure required to obtain the specified mass flow rate, which shall not be appreciably diminished by accidental or steady-state exposure to hot particles or hot material. Their resistance to heat and ultra violet radiation under normal operating conditions shall meet the requirements;

– the fastening of gas hose(s) and pipes to the connecting fittings shall withstand the gas pressure occurring in the event of circuit blockage;

c) electrical features:

– for the high-voltage torch, the hose(s) shall be made of insulated material, with length defined to limit the leakage current to a value below 10 mA;

– a safety device shall prevent the ignition of the torch when the gas circuit is shut off or when the minimum mass flow rate specified by the torch manufacturer is not reached;

– the operator shall have access to the gas circuit control and monitoring devices, to read their indications when desired;

d) other features:

– the compressed gas containers installed close to the place of use of the plasma torch shall be protected against possible overheating, electric discharges and ejections of incandescent material. Similar precautions shall be taken for portable compressed gas containers.

4.1.8 Ignition device

The following specific requirements apply to ignition devices:

a) high-frequency ignition device:

– protection against high voltage, in agreement with the regulations in force in the country where the equipment is to be installed;

b) short-circuit ignition device:

– in general, a high-pressure hydraulic cylinder is used to move the device. The requirements, as defined for the cooling liquid circuit, apply to this device;

– non-flammable and biodegradable hydraulic liquid shall be used.

NOTE The ignition device can be the main source of electromagnetic emissions.

4.1.9 Arc plasma system control

For safety purpose, several emergency push buttons shall be available to shut off the plasma system, through a wired circuit.

4.2 Inductive plasma systems

4.2.1 General requirements

See IEC 60519-1.

4.2.2 Electric circuit

See IEC 60519-1, Clause 6. In addition, 6.4.1 of IEC 60519-1 applies to the complete installation.

4.2.3 Power supply

4.2.3.1 Power supply grounding

The power supply shall be grounded using a separate earth from the main one of the system, so as to avoid possible paths for leakage currents such as those created by the torch control circuits.

4.2.3.2 Connection of the power supply to the torch

The following shall be taken into account: