

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Safety in electroheating installations –
Part 4: Particular requirements for arc furnace installations**
(standards.iteh.ai)

**Sécurité dans les installations électrothermiques –
Partie 4: Exigences particulières pour les installations de fours à arc**

IEC 60519-4:2013
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IEC 60519-4

Edition 4.0 2013-06

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fl 1a292b3222/iec-60519-4-2013

INTERNATIONAL
ELECTROTECHNICAL
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COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

PRICE CODE
CODE PRIX

T

ICS 25.180.10

ISBN 978-2-83220-873-1

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

SAFETY IN ELECTROHEATING INSTALLATIONS –

Part 4: Particular requirements for arc furnace installations

FOREWORD

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International Standard IEC 60519-4 has been prepared by IEC technical committee 27: Industrial electroheating and electromagnetic processing.

This fourth edition cancels and replaces the third edition published in 2006. This edition constitutes a technical revision.

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

- The structure has been amended and adjusted to IEC 60519-1:2010;
- The classification (Clause 4) has been adapted to details with respect to secondary voltage in electric arc furnace installations;
- All provisions have been redrafted and the text is more concise with respect to EAF;
- Annexes AA, BB and CC have been restructured, with respect to details concerning high voltage designs and non-electrical issues, however to be aware of in those installations.

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

FDIS	Report on voting
27/904/FDIS	27/928/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.

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

The clauses of parts of the IEC 60519 series (hereinafter called Particular Requirements) supplement or modify the corresponding clauses of IEC 60519-1:2010 (*General requirements* hereinafter called Part 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 an "addition" to or a "replacement" of the relevant provision of Part 1, these changes are 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.

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 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.

SAFETY IN ELECTROHEATING INSTALLATIONS –

Part 4: Particular requirements for arc furnace installations

1 Scope and object

This clause of Part 1 is replaced by the following.

Replacement:

This part of IEC 60519 provides particular safety requirements for electric arc furnace installations and its operating and maintenance personnel.

These safety provisions concern the protection of persons and the environment against dangers of electrical origin and also against certain dangers of non-electrical origin.

This standard is applicable to electroheating installations such as:

- a) Furnaces for direct arc heating, forming arcs between the electrode and metal such as the electric arc furnace using alternating current (EAFac) or direct current (EAFdc), and ladle furnace (LF);
- b) Furnaces for arc-resistance heating forming arcs between the electrode and the charge material or heating the charge material by the Joule effect, such as the submerged arc furnace using alternating current (SAFac), or direct current (SAFdc).

NOTE For purposes of this document abbreviation EAF is used for all kinds of electric arc furnace installations.

2 Normative references

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

Additions:

IEC 60519-1:2010, *Safety in electroheating installations – Part 1: General requirements*

IEC/TS 60479-1, *Effects of current on human beings and livestock – Part 1: General aspects*

IEC 60676, *Industrial electroheating equipment – Test methods for direct arc furnaces*

IEC 60683, *Industrial electroheating equipment – Test methods for submerged-arc furnaces*

3 Terms and definitions

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

Additions:

NOTE 101 General definitions can be found in the IEC 60050 series, *International Electrotechnical Vocabulary*. Terms relating to industrial electroheat are defined in IEC 60050-841. Terms relating to EAF and SAF are also defined in IEC 60676 and IEC 60683.

3.101

arc furnace

furnace with a vessel, in which a metallic charge is heated mainly by electric arc using alternating current (EAFac) or direct current (EAFdc)

[SOURCE: IEC 60050-841:2004, 841-26-05, modified – the definition has been modified and abbreviations have been added]

3.102

arc furnace transformer

transformer changing medium/high voltage electrical supply to low voltage and high current for an EAF

[SOURCE: IEC 60050-841:2004, 841-26-55, modified – the definition has been modified]

3.103

electric arc furnace using alternating current

EAFac

furnace, in which electric arcs between the electrodes and the process material are formed, using three-phase alternating current

Note 1 to entry: Ladle furnace (LF) is operated under the same conditions.

Note 2 to entry: This note only applies to the French language.

[SOURCE: IEC 60050-841:2004, 841-26-07, modified – the term “alternating current arc furnace” has been replaced by “electric arc furnace using alternating current”, the definition has been modified, and an abbreviation and Notes 1 and 2 have been added]

3.104

electric arc furnace using direct current

EAFdc

furnace, in which the direct current is induced via a bottom electrode (anode) to the material to be processed, forming arcs between the material and the electrode from top (cathode)

[SOURCE: IEC 60050-841:2004, 841-26-06, modified – the term “direct current arc furnace” has been replaced by “electric arc furnace using direct current”, the definition has been modified and an abbreviation has been added]

3.105

EAF electrode

part produced from high density graphite to transfer the electrical energy forming arcs between tip and charge material

Note 1 to entry: In EAFdc, a bottom electrode (anode) is metallic or conductive material in the bottom of an EAF and arcs are formed between the charge material and the graphite electrode from top (cathode).

[SOURCE: IEC 60050-841:2004, 841-26-38, modified – the term “arc furnace electrode” has been replaced by “EAF electrode”, the definition has been modified and Note 1 has been added]

3.106

electrode clamp

metallic, water cooled equipment to hold the electrode and supply current for arcing to the electrode

[SOURCE: IEC 60050-841:2004, 841-26-39, modified – the definition has been editorially improved]

3.107**rectifier for direct current**

device by means of which alternating current is transferred into direct current for EAFdc

3.108**shell**

body of EAF made from steel and covered by a roof

[SOURCE: IEC 60050-841:2004, 841-26-20, modified – the term “arc furnace shell” has been replaced by “shell” and the definition has been modified]

3.109**submerged arc furnace****SAF**

vessel in which a combined arc / resistance heating is used to melt the charged material

[SOURCE: IEC 60050-841:2004, 841-26-12, modified – the term “submerged arc-resistance furnace” has been replaced and the definition has been modified]

4 Classification of electroheating equipment

This clause of Part 1 is applicable, except as follows:

4.2 Classification of electroheating equipment according to process frequency**4.2.1 Direct current equipment**

Addition:

EAFdc and SAFdc are classified as zero (0) frequency. It creates electromagnetic disturbances.

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4.2.101 Secondary voltage

Arc furnaces can be operated with a secondary voltage above 1 000 V a.c. (1 500 V d.c.) under preconditions as follows:

- a) the EAF is switched-on on the primary side of the transformer, since there is no possibility to switch the installation on the secondary side (except installations shown in Figures AA.3 and AA.5);
- b) the insulation of the high current conductors to ground follows the minimum relevant standard IEC 60071-1 for secondary voltages above 1 000 V a.c.

5 General requirements

This clause of Part 1 is applicable, except as follows:

5.1 General

Additions:

5.1.101 All high voltage equipment on the furnace transformer primary side is designed, constructed and enclosed during any operation in accordance with IEC 61936-1:

- a) For arc furnaces with secondary voltage up to 1 000 V a.c. or up to 1 500 V d.c. the minimum relevant standard IEC 60664-1 applies;
- b) standard furnace operation according to the conditions, mentioned in 6.101;

- c) visible information is given in the control room with respect to the status of the high voltage switchgear.

5.2 Electroheating equipment

Additions:

5.2.101 Furnace installations exceeding 1 000 V a.c. shall take into account ionization phenomena due to metallic vapour and pollution at high temperatures which may occur. Insulation and distance between the electric phases shall be considered respectively.

5.2.102 Devices necessary for the operation (i.e. local control facilities, valve stands, lances and manipulators) of the furnace shall be arranged within easy reach of the operator and sufficient protection against live parts.

5.2.103 Devices for operation shall be designed and placed to prevent their unintended activation. Devices for operation with plug connections shall be mechanically locked and shall be designed different to other network connector.

5.2.104 Electrical equipment installed near components with high temperatures during operation shall have sufficient thermal strength and protection.

5.2.105 Precautions shall be taken to avoid any hazard to persons due to transient voltages which might occur during normal operation in circuits comprising transformers, inductors, capacitors and rectifiers for direct current. Equipment shall be designed to suppress and/or withstand high voltages (above 1 000 V) which are normal in the operation of an arc furnace.

5.2.106 Electrical equipment shall be arranged in such way, that it does not deteriorate during normal operation due to physical and chemical effects, including heat load close to the furnace and pollution or electromagnetic forces created by the current during operation. In case it is necessary, suitable measures shall be taken, i.e. gutters or protective channels.

5.6 Electromagnetic compatibility

5.6.1

Addition:

In case of EAFdc, measures shall be taken to avoid the strong magnetic field on electrical devices, i.e. video displays, control units, valves, sensors; the magnetization of parts made from steel shall be considered.

6 Isolation and switching

This clause of Part 1 is applicable, except as follows:

6.1 General

Addition:

In case of EAF, LF and SAF Emergency-Stop devices shall interrupt electrical power supply to the furnace and stop all movements. Regarding EAF, the shell and electrodes shall be brought into safe position in case it is required. Furnace cooling systems shall be kept in function.

Additional subclauses:

6.101 Switching-off

The system shall be switched-off and earthed as shown in Annex AA prior any access is allowed to the roof of an arc furnace or before working in the vicinity of the electrodes, including the bottom electrodes of an EAFdc. Means shall be provided to prevent any unexpected connection of the system. Visual inspection of open circuit breaker or disconnecter is necessary (e.g. by CCTV- Closed Circuit Television). Any equipment under power in the vicinity shall be shielded effectively (for exceptions, see 8.2.102.)

During the status: “furnace breaker OFF”, all jobs, which are defined under EAF operation conditions, can be carried out, as long as safety measures, see 14.3.106, are considered.

Normal EAF operation conditions are:

- slag level measurement;
- slipping and changing of EAF electrodes;
- refining;
- temperature measuring and sampling;
- tapping;
- deslagging;
- charging of scrap or other material etc.;
- small repair work at refractory (patching);
- maintenance of tapping hole and
- all comparable work related to exposure of the personnel

Corresponding to IEC 61936-1 means to protect the persons working on electrical installations shall be valid.

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6.102 Buck-boost supply systems

Buck-boost supply systems (see Figure AA.3) need special care in case the operator has to work on the electrodes. Prior to any contact with the electrodes, the furnace shall be switched-off and all low-voltage connectors shall be earthed safely and solidly.

6.103 Special relays

Special relays for current and voltage shall trip the high-voltage circuit-breaker at any fault of the system during the condition “Furnace-OFF” to ensure that the current-time-function C1 according to IEC/TS 60479-1 will not be exceeded.

6.104 Protection against overcurrent

6.104.1 Relevant, protective measures against overcurrent shall be provided in accordance with IEC 60364-4-43 and IEC 60204-1.

Protective measures against overcurrent (overloads and short circuits) shall be provided, even if in excess of the scope specified in these standards.

NOTE IEC 60364-4-43 refers to the protection of cables and wiring up to 1 000 V.

6.104.2 The circuit breaker used to connect the electroheating installation to the power supply shall be capable to switch-off safely all current, which may occur, including fault current.

When two switches are arranged in series or parallel, they shall be capable of carrying and switching-off all current safely which may arise, including fault currents.

7 Connections to the electrical supply network and internal connections

This clause of Part 1 is applicable.

8 Protection against electric shock

This clause of Part 1 is applicable, except as follows:

8.2 Direct contact – special measures

Replacement:

8.2.101 General

Direct contact with live parts shall not be permitted. However, using special equipment and tools designed for this purpose, certain operational procedures may allow contact with live parts, which shall be agreed with local authorities.

8.2.102 Special conditions for SAF

In case of SAFac or SAFdc, in continuous operation, the inspection of the electrode paste level, electrode additions or welding of electrode casings will be permitted on live parts at voltages above 1 000 V a.c. or 1 500 V smooth d.c. under the following conditions, to be fulfilled simultaneously:

- the rated voltage of the installation does not exceed 2 400 V a.c. or 3 000 V smooth d.c.;
- redundant insulation between support structure of electrode working platform and ground (steel structure);
- wooden working platform;
- redundant insulation of crane for electrodes to ground;
- separation of working platform to ground;
- separation walls shall exceed live electrodes by at least 300 mm;
- only instructed and authorized personnel is able to access to the working platform (restricted by lockable doors);
- ladders of non-conductive material shall be used;
- tools (e.g. welding machine, grinding machine) shall be insulated to ground;
- information signs to be installed according to IEC 60519-1:2010, 13.2.

8.3 Indirect contact – special measures

Replacement:

8.3.101 General

All accessible metal parts at the arc furnace, which are liable to become accidentally live in the event of an insulation fault, shall be electrically connected to an earth terminal or to an earth contact of the connector plug by the shortest possible path, as safely and solidly as possible.

8.3.102 Protection against overvoltage

Special precautions shall be taken to avoid excessive overvoltages on the primary side and on the secondary side of the arc furnace transformer, which could damage the installation.

9 Equipotential bonding

This clause of Part 1 is applicable, except as follows:

9.4 Prohibition of the use of earth as part of an active circuit

Addition:

9.4.101 Tilt tracks shall not be used as return circuit.

10 Control circuits and control functions

This clause of Part 1 is applicable.

11 Protection against thermal influences

This clause of Part 1 is applicable.

12 Protection against other hazards

This clause of Part 1 is applicable.

13 Marking, labelling and technical documentation

This clause of Part 1 is applicable, except as follows:

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13.1 Marking

13.1.1 *Addition:*

aa) identification of the principal connections (i.e. reference number of a drawing showing the principal circuit of the furnace).

Addition:

13.1.101 The preferred location of the nameplate is on the main furnace control panel. In case of significant changes in the installation, the nameplate shall be updated.

14 Commissioning, inspection, operation and maintenance

This clause of Part 1 is applicable, except as follows:

14.1 General requirements

Addition:

14.1.101 Additional requirements concerning the electrical isolation shall be issued by the manufacturer in separate instructions to be posted in the switching area and/or instructions to be given to the trained personnel, for which acknowledgment shall be given.

14.2 Commissioning and inspection

Addition:

Tests shall be carried out for EAF/LF according to IEC 60676 and for SAF according to IEC 60683.

14.3 Safety instructions for operation

Additions:

14.3.101 Personnel shall wear appropriate Personal Protective Equipment (PPE) suitable for working at the furnace.

14.3.102 Access to current-carrying parts of the furnace, including the bottom electrode system of an EAFdc, shall be permitted for trained personnel only.

14.3.103 Personnel shall be warned of possible hazards associated with the furnace. In addition, they shall be warned of any hazardous area underneath the furnace and the area of current carrying conductors by warning signs. Access to the hazardous areas shall be prevented by barriers as far as practicable.

14.3.104 Changing and jointing of electrodes including work on electrode accessories shall not be carried out unless protective measures, stated in 6.101 have been ensured. This also applies for automatic electrode jointing.

14.3.105 Deviation from the requirements in 14.3.104 is permitted, in case safety of the personnel is fully ensured by other suitable precautions (for example, insulation of the operator's place, safe distance, use of insulated tools and contact with only one electrode).

14.3.106 Tools, lances (for oxygen, bath temperature) and other metallic devices to be used at a furnace during operation shall be earthed effectively. Their accessible metal parts shall be insulated or only be used by personnel insulated against earth (e.g. standing on an insulated platform). Where practicable the length of any device, including car charger arms, shall be such that any approach to the electrode is prevented. In case this is not possible, proper operating procedures shall be defined in the operation manual by the manufacturer and practised (i.e. electrodes are raised and held raised during operation). In case of an automatic lance, it shall be earthed adequately and angled so that it is dipped into the metal well away from the electrodes.

The above requirements do not necessarily apply to EAFdc where alternative adequate precautions shall be taken to avoid any voltage hazardous to personnel.

14.4 Instructions for maintenance work

Additions:

14.4.101 Suitable safety precautions shall be taken servicing the furnace from inside to prevent the electrodes, electrode pieces or scrap dropping into the furnace, especially in case residual hot metal and liquid slag is inside the furnace.

14.4.102 The following precautions shall be taken during welding on the cooling system inside the hot furnace:

- a) Relevant cooling components shall be shut-off and drained of any liquid.
- b) All drives of moveable components of the furnace, which are hazardous, shall be switched-off and blocked if necessary.
- c) If any material is used to cover the hot parts of the furnace bottom and/or the hot heel, it should not produce dangerous gases with increasing temperature.

- d) For heat protection of personnel doing the welding, a basket with thermal insulation is recommended. The basket shall be built and maintained in accordance with national standards.
- e) The welding machines and other electric tools used for maintenance inside the furnace shall be suitable and in accordance with national standards.

14.4.103 During maintenance on the secondary current conductors or near to them using auxiliary voltages, access to all transformer terminals and windings shall be prevented, unless those windings are short-circuited and earthed, since dangerous voltages may be produced in the other electrical windings.

Same precautions apply to instruments and control devices connected to the secondary side.

No maintenance on the tap changer and its components, no electrical welding and no working on the secondary side of the transformer is permitted unless the high voltage windings of the transformer are earthed adequately.

NOTE See also Annex AA and 9.4 of IEC 60519-1:2010.

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