BS EN 60519-4:2013

BSI Standards Publication

Safety in electroheating installations

Part 4: Particular requirements for arc furnace installations

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National foreword

This British Standard is the UK implementation of EN 60519-4:2013. It is identical to IEC 60519-4:2013. It supersedes BS EN 60519-4:2006 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PEL/27, Electroheating.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Published by BSI Standards Limited 2013

ISBN 978 0 580 73646 9
ICS 25.180.10

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 September 2013.

Amendments/corrigenda issued since publication

Date	Text affected

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 60519-4

August 2013

ICS 25.180.10

Supersedes EN 60519-4:2006

English version

Safety in electroheating installations - Part 4: Particular requirements for arc furnace installations

(IEC 60519-4:2013)

Sécurité dans les installations électrothermiques - Partie 4: Exigences particulières pour les installations de fours à arc (CEI 60519-4:2013)

Sicherheit in Elektrowärmeanlagen - Teil 4: Besondere Bestimmungen für Lichtbogenofenanlagen (IEC 60519-4:2013)

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Avenue Marnix 17, B - 1000 Brussels

Ref. No. EN 60519-4:2013 E

Foreword

The text of document 27/904/FDIS, future edition 4 of IEC 60519-4, prepared by IEC/TC 27 "Industrial electroheating and electromagnetic processing" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 60519-4:2013.

The following dates are fixed:

• latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2014-04-24
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2016-07-24

The clauses of parts of the EN 60519 series (hereinafter called Particular requirements) supplement or modify the corresponding clauses of EN 60519-1:2011 (*General requirements* hereinafter called Part 1).

This part of EN 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.

This document supersedes EN 60519-4:2006.

EN 60519-4:2013 includes the following significant technical changes with respect to EN 60519-4:2006:

– The structure has been amended and adjusted to EN 60519-1:2011;

– 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.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

This standard covers the Principle Elements of the Safety Objectives for Electrical Equipment Designed for Use within Certain Voltage Limits (LVD - 2006/95/EC).

Endorsement notice

The text of the International Standard IEC 60519-4:2013 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following note has to be added for the standard indicated:

IEC 60073:2002	NOTE	Harmonised as EN 60073:2002 (not modified).

Annex ZA
(normative)
Normative references to international publications with their corresponding European publications

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC/TS 60479-1	-	Effects of current on human beings and livestock - Part 1: General aspects	-	-
IEC 60519-1 + corr. November	2010 2012	Safety in electroheating installations - Part 1: General requirements	EN 60519-1	2011
IEC 60676	-	Industrial electroheating equipment - Test methods for direct arc furnaces	EN 60676	-
IEC 60683	-	Industrial electroheating equipment - Test methods for submerged arc furnaces	EN 60683	-

CONTENTS

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.

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 disconnector 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.

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:

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.

Annex A
(normative)

Protection against electric shock – special measures

Annex A of Part 1 is not applicable.

Annex AA
(normative)

Systems to assure improved safety for personnel working in the vicinity of electrodes and other live parts of secondary circuit

In view of increased voltages and/or new switching techniques, one of the following design arrangements are required to safeguard the personnel:

a) high-voltage furnace switch and high-voltage furnace breaker in open position and high-voltage disconnector in open position (see Figure AA.1);

b) high-voltage furnace switch or high-voltage furnace breaker in open position and high-voltage earthing switch in closed position (see Figure AA.2);

c) for buck-boost (intermediate circuit) transformer: intermediate circuit switch in open position and low-voltage earthing and short-circuiting devices in closed position (see Figure AA.3);

d) high-voltage furnace switch or high-voltage furnace breaker in open position and high-voltage disconnector switch in open position. Firing pulses are stopped (see Figure AA.4);

e) high-voltage furnace switch or high-voltage furnace breaker in closed position and low-voltage disconnector switch in open position. Firing pulses are stopped (see Figure AA.5).

In case of Figures AA.1, AA.2, AA.4 and AA.5, no protection is provided against any accidental energizing on the secondary side. To maintain the potential on the secondary side of the transformer near to earth, additional means shall be provided.

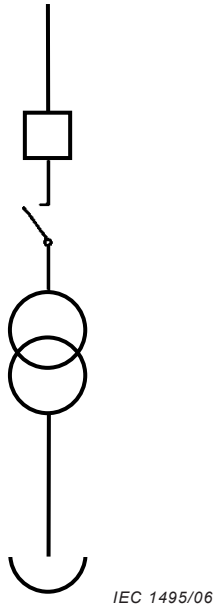


Figure AA.1 – Arc furnace supply with HV furnace switch (or HV furnace breaker) in open position and HV disconnector in open position

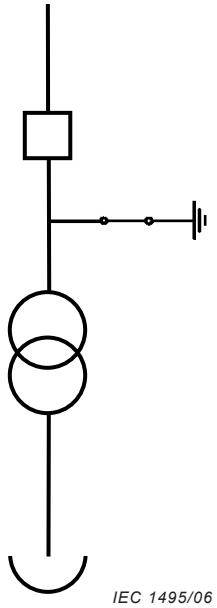
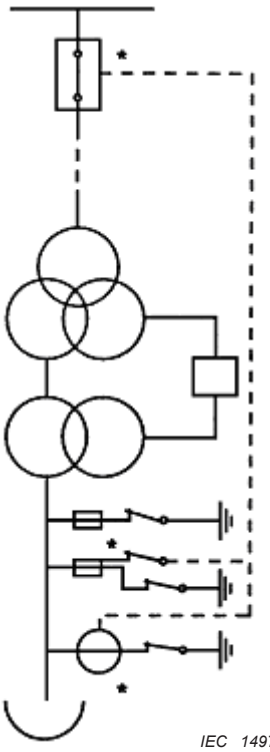


Figure AA.2 – Arc furnace supply with HV furnace switch (or HV furnace breaker) in open position and HV earthing switch in closed position



* Special indicators are provided to trip the HV circuit-breaker at any fault during the condition furnace off.

Figure AA.3 – Arc furnace supply with buck-boost transformer or intermediate circuit transformer

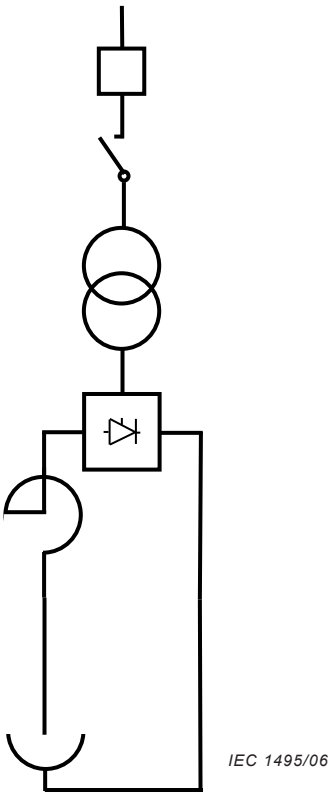


Figure AA.4 – DC furnace supply with HV furnace switch (or HV furnace breaker) in open position and HV disconnector in open position

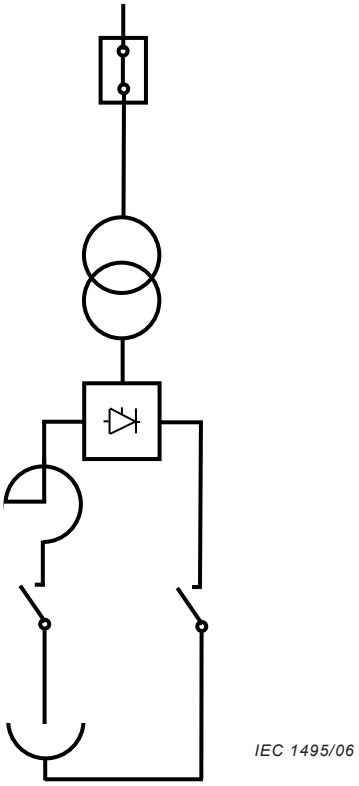
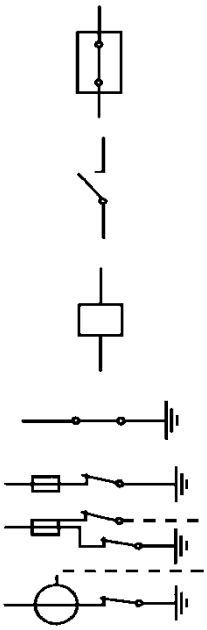


Figure AA.5 – DC furnace supply with HV furnace switch (or HV furnace breaker) in closed position, valve firing pulses stopped and LV disconnector switch in open position

Key to Figures AA.1 to AA.5



HV circuit breaker closed

HV disconnect switch open

HV furnace switch or HV furnace breaker open
or intermediate circuit switch open

HV earthing switch closed in accordance with fault level

LV short-circuiting and earthing devices closed to keep the potential near zero

NOTE Symbols shown indicate the required position of the switchgear to permit electrode handling and associated operations to take place.

Annex BB
(normative)

Additional requirements for the safety of non-electrical components of furnace installations

NOTE The following safety requirements are minimum requirements.

BB.1 Water cooling system for shell and roof

BB.1.1 In addition to the requirements given in IEC 60519-1:2010, 5.8, for the electrical systems, the following requirements apply.

BB.1.2 The cooling system shall be divided into a number of separately controlled and monitored circuits. The flow rate and, where necessary, the outlet temperature, of each group of parallel components shall be monitored. Any inadmissible deviation of the measured values from the specified rated figures shall be considered as fault indication.

BB.1.3 Overpressure valves shall be provided for each closed cooling system. Adequate means are necessary to ensure that no inadmissible overpressure occurs during maintenance.

BB.1.4 Overpressure valves, hoist couplings and other outlets shall be, as far as practicable, located outside the working area of the furnace.

BB.2 Evaporation cooling for shell and roof

BB.2.1 With evaporation cooling, the cooling system for the shell and roof shall be divided into a number of separate circuits.

BB.2.2 In the individual circuits, the supply flow rates shall be monitored. Any inadmissible deviation of the measured values from the specified rated figures shall be considered as fault indication.

Each circuit shall be equipped with means of adjustment for the supply.

Moreover, it shall be possible to cut off each circuit separately by means of a non-return valve and/or a manually operated valve.

BB.2.3 For all common components of the cooling system, such as the steam collecting drum and pumps, the relevant national safety regulations apply.

BB.3 Tapping alternatives

BB.3.1 Bottom tapping (centric)

In the case water cool flanges are needed underneath the furnace, the water flow rate and temperature in the return line shall be measured.

BB.3.2 Eccentric bottom tapping

See BB.3.1. The tapping procedure shall be supervised with the use of a tilt angle indicator.

BB.4 Burners (supplementary burners)

At the burners, each supply shall be monitored adequately.

By suitable instructions and/or interlocks, it shall be ensured that the burners, which are not provided with an ignition system, are only used in case the furnace is hot and the electric arcs are ignited.

In case burners are also used to heat the charge during a shutdown period of the furnace, the burners shall be equipped with a positive ignition device (i.e. a pilot flame).

Annex CC
(normative)

Additional requirements for safety with respect to design of an installation

CC.1 General

The philosophy of safety is always important; in case the safety cannot be strictly applied due to technological developments, the following requirements are still to be met:

a) the risk of loss of insulation between the electrodes and the roof and furnace frame shall be totally eliminated by adequate engineering measures;

b) all parts of the furnace, which are accessible to the operator, shall be earthed. In case earthing is impossible or hazardous, special measures shall be taken to impede the presence of persons in zones of risk;

c) in case the furnace tilting device fails during normal operation, adequate safety measures are necessary;

d) any risk of electrical shocks, to which the crane operator may be exposed, shall be taken into account in the furnace installations.

CC.2 Electrodes and their auxiliaries

CC.2.1 The electrode holding structure (gantry) (electrode positioning mechanism) shall be insulated from the drive mechanism and from the furnace frame. Drive mechanism and frame of the furnace shall be earthed adequately.

CC.2.2 Each electrode moving system shall be provided with two limit switches or comparable devices. At the first limit switch, the movement of the electrode into top position shall be stopped. The second switch or device is intended to detect any overshot (see also CC.4.4).

NOTE A second limit switch is not necessary if end-of-travel stoppage is inherent in the design of the electrode moving system.

CC.2.3 In case of self-baking electrodes (Söderberg electrodes), care shall be taken that the upper clamp of the electrode is firmly closed prior the lower electrode clamp is opened. For pneumatic type slipping systems, the air supply shall be backed-up by a pressurized air tank of sufficient capacity.

CC.2.4 Mechanical locking, means to enable safe servicing, shall be provided, to prevent any uncontrolled movement of the electrode mast.

CC.2.5 All motions of electrode moving systems shall be controlled by suitable interlocks or similar devices to prevent any damage of the components.

CC.3 Water-cooled electrodes

CC.3.1 Combination electrodes

On water-cooled electrodes the flow rate and temperature of the non-conductive cooling water is necessary and a leakage monitoring system shall be provided which interrupts the energy supply to the furnace, shuts-off the water supply (supply and return lines) and lifts the electrode.

CC.3.2 Spray cooling

Electrodes cooled by spray water, shall be equipped with means to adjust the water supply that the water evaporates totally on the surface of the electrode during operation including tapping.

Adequate means are necessary to shut-off the spray cooling (possibly after temporizing) when the furnace is switched-off.

CC.4 Furnace shell and roof

CC.4.1 Each type of furnace shell shall be earthed either directly or by connecting it to the metallic shell-to-foundation assembly, which shall be earthed.

NOTE 1 The roof of a submerged arc furnace can be insulated from earth.

NOTE 2 The shell of a rotating submerged arc furnace can be earthed via a current-limiting resistance to prevent a fault current which could cause burning of the earthing wire or damage to the wheel bearings.

In this case an overvoltage relay shall be provided to disconnect the furnace if a dangerous voltage arises between furnace shell and earth. Means to prevent any uncontrolled movement of the furnace shall be provided to enable safe service.

CC.4.2 Components of the furnace, which can be moved, for example, tilting or rotating of shell, swinging of roof, shall be controlled by suitable interlocks or similar devices.

CC.4.3 In case of any failure of the furnace tilting mechanism, means shall be provided to enable the furnace to return to or remain at a safe position.

CC.4.4 Each movement of a furnace component shall be limited by a mechanical end stop and if required, by an overshot limit switch.

CC.4.5 Access to the upper structure of a furnace (roof, gantry and electrode arms) shall be impossible, unless the furnace has been switched-off safely. See Annex AA for exceptions.

CC.4.6 Furnaces shall be provided with a mechanism to lift the electrodes into safe position prior re-ignition. In the case of electrical supply interruption, the electrodes shall rest in their position or, if necessary, be brought into a safe position.

CC.5 Charging, deslagging and tapping

CC.5.1 Charging equipment as integral component of the furnace installation shall be earthed by practicable and durable means or insulated electrically by suitable methods.

CC.5.2 Shelters for safeguard against flames, hot particles, falling scrap, etc. shall be provided, with adequate protection and escape routes. Similar protection and access shall be provided for any charging equipment, independently of the furnace.

CC.5.3 Deslagging and tapping areas are dangerous, access to these areas shall be restricted to skilled and authorized personnel only.

CC.6 Additional requirements

CC.6.1 Water accumulation in the areas of deslagging and tapping shall be avoided. Measures shall be taken to remove any water from the tapping area in the event of a leakage.

This requirement is not applicable to furnace installations with granulating facilities. In this case, special safety provisions shall be applied in order to avoid hazards of explosion.

CC.6.2 Various parts of the furnace requiring supervision and maintenance (electrical insulation, electrode arms, electrode holder equipment, cooling components, servomotors, etc.) shall be accessible. Ladders, platforms, walkways and other means shall be provided for this purpose, as far as practicable.

All workplaces shall be provided with hand and toe rails in accordance with national standards.

CC.6.3 Tapping pits for ladles shall be built with ample space for free ladle handling.

They shall be surrounded, as far as practicable, by hand and toe rails in accordance with national standards.

CC.6.4 Gas storage vessels (gas cylinders), pipe work and associated equipment in vicinity of the furnace, shall be protected against possible overheating, electric discharges and splashing of red hot material. Similar safety precautions shall be taken for portable pressurized vessels (i.e. gas cylinders or spherical gas containers on carriages).

CC.6.5 The power-on switch of a furnace is normally controlled by a key; its removal shall not be possible unless the switch is in off-position.

CC.6.6 Optical signals visible for all persons in the vicinity of the furnace shall indicate "Furnace in operation" (whether switched on or switched off). Prior the furnace is switched on, an additional alarm shall be given.

NOTE Not applicable for submerged arc furnaces (SAF).

CC.6.7 Electrical switch-on of a furnace shall only be possible from the main control panel. In case of special maintenance situations, a remote switch-on of the furnace is only permitted in safe working conditions.

CC.6.8 Any contact of conductive parts of the furnace with crane ropes shall be avoided. Interlocks shall be provided whereby live parts cannot get in contact with crane ropes.

Bibliography

The Bibliography of Part 1 is applicable with the following addition.

Addition:

IEC 60073:2002, *Basic and safety principles for man-machine interface, marking and identification – Coding principles for indicators and actuators*

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