Industrial electroheating equipment - Test methods for direct arc furnaces

EESTI STANDARDIMIS- JA AKREDITEERIMISKESKUS
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NATIONAL FOREWORD

See Eesti standard EVS-EN IEC 60676:2024 sisaldab Euroopa standardi EN IEC 60676:2024 ingliskeelset teksti.	This Estonian standard EVS-EN IEC 60676:2024 consists of the English text of the European standard EN IEC 60676:2024.
Standard on jõustunud sellekohase teate avaldamisega EVS Teatajas.	This standard has been endorsed with a notification published in the official bulletin of the Estonian Centre for Standardisation and Accreditation.
Euroopa standardimisorganisatsioonid on teinud Euroopa standardi rahvuslikele liikmetele kättesaadavaks 05.04.2024.	Date of Availability of the European standard is 05.04.2024.
Standard on kättesaadav Eesti Standardimis-ja Akrediteerimiskeskusest.	The standard is available from the Estonian Centre for Standardisation and Accreditation.

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EUROPEAN STANDARD

NORME EUROPÉENNE

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English Version

Industrial electroheating equipment - Test methods for direct arc furnaces (IEC 60676:2024)

Chauffage électrique industriel - Méthodes d'essai des fours à arc direct (IEC 60676:2024)

Industrielle Elektrowärmeanlagen - Prüfverfahren für Lichtbogen-Schmelzöfen (IEC 60676:2024)

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CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

Ref. No. EN IEC 60676:2024 E

European foreword

The text of document 27/1181/FDIS, future edition 4 of IEC 60676, prepared by IEC/TC 27 "Industrial electroheating and electromagnetic processing" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 60676:2024.

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) 2025-01-03
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2027-04-03

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The text of the International Standard IEC 60676:2024 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standard indicated:

The Bibliography of EN 60398:2015 is applicable with the following addition:

IEC 60076 (series) NOTE Approved as EN 60076 (series)

IEC 60146-1-1 NOTE Approved as EN 60146-1-1

IEC 60683:2011 NOTE Approved as EN 60683:2012 (not modified)

IEC 61869 (series) NOTE Approved as EN IEC 61869 (series)

IEC 60676

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INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Industrial electroheating equipment – Test methods for direct arc furnaces

Chauffage électrique industriel – Méthodes d'essai des fours à arc direct

IEC 60676:2024-02(en-fr)

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Edition 4.0 2024-02

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Industrial electroheating equipment – Test methods for direct arc furnaces

Chauffage électrique industriel – Méthodes d'essai des fours à arc direct

INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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INDUSTRIAL ELECTROHEATING EQUIPMENT – TEST METHODS FOR DIRECT ARC FURNACES

FOREWORD

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IEC 60676 has been prepared by IEC technical committee 27: Industrial electroheating and electromagnetic processing. It is an International Standard.

This fourth edition cancels and replaces the third edition published in 2011. This edition constitutes a technical revision.

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

a) The structure has been redrafted according to IEC 60398:2015.
b) The scope has been redrafted.
c) The terms/definitions, normative references and bibliography have been updated and completed.
d) The test methods and content from IEC 60398:2015 have been confirmed, replaced, or complemented with regards to direct arc furnaces (EAF, LF).

e) The annexes from IEC 60398:2015 have been confirmed, replaced, or complemented with regards to direct arc furnaces (EAF, LF).

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

Draft	Report on voting
27/1181/FDIS	27/1184/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 standard is to be read in conjunction with IEC 60398:2015. It supplements or replaces the corresponding clauses of IEC 60398:2015. Where the text indicates a "modification" of, "addition" to or a "replacement" of the relevant provision of IEC 60398:2015, these changes are made to the relevant text of IEC 60398:2015. Where no change is necessary, the words "This clause of IEC 60398:2015 is applicable" are used. When a particular subclause of IEC 60398:2015 is not mentioned in this standard, that subclause applies as far as it is reasonable. When a particular subclause of IEC 60398:2015 is not applicable, the word "Void" is used.

In this standard, the following print types are used:

- terms defined in Clause 3: **bold type**.

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.

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INTRODUCTION

Direct electrical arc furnaces are very important applications for steel scrap melting, melting of direct reduced iron (DRI), hot bricked iron (HBI) or hot metal. While ladle furnaces are mainly used for providing the required quality and final adjustment of temperature of molten steel before sending to casting machine or to vacuum treatment stations.

The manufacturer of the installation or equipment usually fulfils the following requirements, which come from different sources and are quite often in this order of priorities:

a) to enable the intended process and make the installation work properly;

b) to be cost effective during design and manufacturing;

c) to ensure that the equipment is safe to use in the sense of providing freedom from unacceptable risk of physical injury or damage to the health of the operator (safety in the narrower sense of ISO 12100:2010);

d) to ensure that the equipment is safe to use in the sense of providing freedom from unacceptable risk or physical injury or damage to the health of people, or damage to property or the environment (adding other safety aims to item c), and in the much broader definition of safety according to ISO/IEC Guide 51);

e) to prove that the equipment is cost effective to operate and uses sufficiently small amounts of energy, material and other resources.

It is usually part of the proprietary knowledge of the manufacturer or user of the equipment, to make it cost effective or enable intended processes with a benefit. IEC 60519-1 and IEC 60519-4 assist with achieving safety in the ISO 12100:2010 sense. The focus of this document is on basic requirements for measuring instrumentation and test methods concerned with energy and resource efficiency, performance of the intended process and assessing cost of ownership for installations and equipment.

This document presumes that the installation or equipment is operated and maintained only by personnel consisting of skilled or instructed persons.

INDUSTRIAL ELECTROHEATING EQUIPMENT – TEST METHODS FOR DIRECT ARC FURNACES

1 Scope

This clause of IEC 60398:2015 is replaced by the following.

Replacement:

This document specifies the basic test procedures, conditions and methods for establishing the main performance parameters and the main operational characteristics of furnaces for direct arc heating, forming arcs between the **electrode** and metal, such as electric arc furnaces using alternating current (**EAF AC**) or direct current (**EAF DC**), and ladle furnaces (LF), with rated power level above 500 kVA .

Measurements and tests that are solely used for the verification of safety requirements of equipment for direct electrical arc furnaces are outside the scope of this document and are covered by IEC 60519-1, IEC 60519-4 and ISO 13578.

This document is applicable for the commissioning, verification of design improvements or for energy related tasks with respect to energy use or energy efficiency, establishing of an energy baseline, and labelling. Some concepts from this document can directly be used as key performance indicators.

Detailed tests for specific types of electric arc furnace equipment and installations are beyond the scope of this document. This document is intended as general reference for all future test standards applicable to particular electric arc furnace equipment or installations.

This document includes the concept and material presented in IEC 60398 on energy efficiency dealing with the electrical and processing parts of the equipment, as well as the overall performance.

Test methods for some special equipment, e.g., semiconductor converters, are covered by IEC 60146-1-1 and **furnace transformers** are covered by IEC 60076 series.

Test methods for submerged arc furnaces (SAF) are covered by IEC 60683.

2 Normative references

This clause of IEC 60398:2015 is replaced by the following.

Replacement:

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 60398:20215, *Installations for electroheating and electromagnetic processing – General performance test methods*

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

IEC 60519-4:2021, *Safety in installations for electroheating and electromagnetic processing – Part 4: Particular requirements for arc furnace installations*

ISO 13578, *Industrial furnaces, and associated processing equipment – Safety requirements for machinery and equipment for production of steel by electric arc furnaces*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60398:2015 and the following apply.

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

- ISO Online browsing platform: available at https://www.iso.org/obp
- IEC Electropedia: available at https://www.electropedia.org

NOTE The terms and definitions refer to EAF and/or LF where applicable.

3.1.101
active power
P
under periodic conditions, mean value, taken over one period T of the instantaneous power p

$$P = \frac{1}{T}\int_0^T p\ dt$$

Note 1 to entry: Under sinusoidal conditions, the active power is the real part of the complex power S, thus P = Re (S).

Note 2 to entry: The coherent SI unit for active power is Watt, W.

[SOURCE: IEC 60050-131:2002, 131-11-42]

3.1.102
apparent power
S
power rating of the **furnace transformer**, energizing the EAF or LF (in MVA)

$$S = \sqrt{3}\ UI \qquad \text{(for three-phase system)}$$

where

U is the voltage, RMS, sinusoidal value [in kV]

I is the current, RMS sinusoidal value [in kA]

[SOURCE: IEC 60050-131:2002, 131-11-41, modified – more precise]