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**Industrial furnaces and associated  
processing equipment — Safety  
requirements for machinery and  
equipment for production of steel by  
electric arc furnaces**

*Fours industriels et équipements associés — Exigences de sécurité  
pour les machines et les équipements pour la production d'acier par  
four à arc électrique*  
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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html). (standards.iteh.ai)

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## Introduction

This document is a type C standard as stated in ISO 12100.

The machinery concerned and the extent to which hazards, hazardous situations and events are covered are indicated in the scope of this document.

When provisions of this type C standard are different from those which are stated in type A or B standards, the provisions of this type C standard take precedence over the provisions of the other standards for machines that have been designed and built according to the provisions of this type C standard.

Where, for clarity, an example of a preventive measure is given in this document, this should not be considered as the only possible solution. Any other solution leading to the same risk reduction is permissible, if an equivalent level of safety is achieved.

This document is of relevance, in particular, for the following stakeholder groups representing the market players with regard to machinery safety:

- machine manufacturers (small, medium and large enterprises);
- health and safety bodies (regulators, accident prevention organizations, market surveillance, etc.).

Others can be affected by the level of machinery safety achieved by these stakeholder groups through the use of this document:

- machine users/employers (small, medium and large enterprises);
- machine users/employees (e.g. trade unions, organizations for people with special needs);
- service providers, e.g. for maintenance (small, medium and large enterprises);
- consumers (in case of machinery intended for use by consumers).

The above-mentioned stakeholder groups have been given the possibility to participate at the drafting process of this document.

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# Industrial furnaces and associated processing equipment — Safety requirements for machinery and equipment for production of steel by electric arc furnaces

## 1 Scope

This document specifies the general safety requirements for electric arc furnaces (EAF) to melt steel not containing radioactive material.

NOTE Radioactive material is considered to be detected in front of the steel plant entrance.

This document deals with significant hazards, hazardous situations and events as listed in [Table 1](#) pertinent to EAF, when used as intended and under conditions foreseen by the manufacturer, and also includes foreseeable faults and malfunctions in case of misuse.

This document also specifies criteria for the plant and equipment integrated in the production process.

This document specifies the requirements to be followed during design to ensure the safety of persons, which are to be met during transport, assembly, commissioning, operation, maintenance and decommissioning of the equipment.

This document assumes that installations are operated and maintained by adequately trained personnel. Manual intervention for setting, adjustment and maintenance is accepted as part of the normal use of the equipment.

This document covers the following equipment (see [Annex B](#), [Tables B.1](#) and [B.2](#), and [Annex C](#), [Figures C.1](#) and [C.2](#)):

- EAF with alternating current (AC) technology;
- EAF with direct current (DC) technology;
- scrap preheating technology;
- associated equipment/devices (e.g. inert gas stirring, carbon and oxygen injection systems).

The following equipment is not covered by this document:

- induction furnace;
- resistance-arc furnace (e.g. submerged arc furnace);
- electron beam furnace;
- plasma furnace;
- other electrical furnaces used in secondary steelmaking, e.g. ladle furnace.

This document does not specify safety requirements for the following equipment, which can be an integral or complementary part of the equipment covered by the scope:

- cranes;
- shell lifting cross beam;
- scrap basket, steel ladle and slag pot;
- transport cars for scrap baskets, steel ladles and slag pots;

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- dedusting system;
- “dog house” and “elephant house” (furnace enclosures for environmental reasons);
- alloying system;
- separate scrap drying equipment;
- furnace transformer and high-voltage system;
- robots/manipulators (e.g. for temperature measurement and sampling).

## 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.

ISO 3864-1, *Graphical symbols — Safety colours and safety signs — Part 1: Design principles for safety signs and safety markings*

ISO 3864-2, *Graphical symbols — Safety colours and safety signs — Part 2: Design principles for product safety labels*

ISO 3864-3, *Graphical symbols — Safety colours and safety signs — Part 3: Design principles for graphical symbols for use in safety signs*

ISO 4413, *Hydraulic fluid power — General rules and safety requirements for systems and their components*

ISO 4414, *Pneumatic fluid power — General rules and safety requirements for systems and their components*

ISO 4871, *Acoustics — Declaration and verification of noise emission values of machinery and equipment*

ISO 7010, *Graphical symbols — Safety colours and safety signs — Registered safety signs*

ISO 7731, *Ergonomics — Danger signals for public and work areas — Auditory danger signals*

ISO 8995-1, *Lighting of work places — Part 1: Indoor*

ISO 11064-1, *Ergonomic design of control centres — Part 1: Principles for the design of control centres*

ISO 11202, *Acoustics — Noise emitted by machinery and equipment — Determination of emission sound pressure levels at a work station and at other specified positions applying approximate environmental corrections*

ISO 11428, *Ergonomics — Visual danger signals — General requirements, design and testing*

ISO 11429, *Ergonomics — System of auditory and visual danger and information signals*

ISO/TR 11688-1, *Acoustics — Recommended practice for the design of low-noise machinery and equipment — Part 1: Planning*

ISO 12100:2010, *Safety of machinery — General principles for design — Risk assessment and risk reduction*

ISO 13574, *Industrial furnaces and associated processing equipment — Vocabulary*

ISO 13732-1, *Ergonomics of the thermal environment — Methods for the assessment of human responses to contact with surfaces — Part 1: Hot surfaces*

ISO 13849 (all parts), *Safety of machinery — Safety-related parts of control systems*

ISO 13857, *Safety of machinery — Safety distances to prevent hazard zones being reached by upper and lower limbs*



ISO 14120, *Safety of machinery — Guards — General requirements for the design and construction of fixed and movable guards*

ISO 14122-1, *Safety of machinery — Permanent means of access to machinery — Part 1: Choice of fixed means and general requirements of access*

ISO 14122-2, *Safety of machinery — Permanent means of access to machinery — Part 2: Working platforms and walkways*

ISO 14122-3, *Safety of machinery — Permanent means of access to machinery — Part 3: Stairs, stepladders and guard-rails*

ISO 14122-4, *Safety of machinery — Permanent means of access to machinery — Part 4: Fixed ladders*

ISO 16069, *Graphical symbols — Safety signs — Safety way guidance systems (SWGS)*

IEC 60204-1:2016, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements*

IEC 60519-4, *Safety in electroheat installations — Part 4: Particular requirements for arc furnace installations*

IEC 61310-1, *Safety of machinery — Indication, marking and actuation — Part 1: Requirements for visual, acoustic and tactile signals*

IEC 61310-2, *Safety of machinery — Indication, marking and actuation — Part 2: Requirements for marking*

IEC 61310-3, *Safety of machinery — Indication, marking and actuation — Part 3: Requirements for the location and operation of actuators*

IEC 61511-1, *Functional safety — Safety instrumented systems for the process industry sector — Part 1: Framework, definitions, system, hardware and application programming requirements*

IEC 62061, *Safety of machinery — Functional safety of safety-related electrical, electronic and programmable electronic control systems*

### 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12100 and ISO 13574 and the following apply.

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

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

#### 3.1

##### **heat cycle**

tap-to-tap time period between two consecutive tappings with defined power-on and power-off time

#### 3.2

##### **ladle**

vessel to collect, transport and charge/discharge hot metal/steel

#### 3.3

##### **workstation**

predefined locations for personnel conducting control, production or *maintenance* (3.18) activities

Note 1 to entry: The main workstations are *EAF control room* (3.3.1), *local control stands* (3.3.2), and *portable wireless control box* (3.3.3).

**3.3.1**

**EAF control room**

main control room in which the control consoles and monitoring facilities for an EAF are located

Note 1 to entry: A location where operating personnel are required permanently during the production process.

**3.3.2**

**local control stand**

control units usually situated adjacent to the equipment

Note 1 to entry: A location where operating personnel are required temporarily during the production process, e.g. during tapping.

**3.3.3**

**portable wireless control box**

mobile control units connected to the control system

Note 1 to entry: A portable wireless control box can be used, e.g. to position the equipment more precisely.

**3.4**

**tilting**

movement of the furnace to discharge molten steel or slag from foreseen openings

**3.5**

**blocking device**

device to block the equipment in the desired position

**3.6**

**gantry**

structure used for lifting and swinging roof and columns/electrode arms

**3.7**

**high-voltage switch gear**

furnace breaker to connect and disconnect the EAF to/from electrical high-voltage supply

**3.8**

**reactor**

device to increase the reactance of the EAF system

**3.9**

**furnace transformer**

device for the transformation of the high-voltage electrical supply to arc voltage

**3.10**

**alloying system**

device to store and feed any metallic and non-metallic materials to/into the EAF

**3.11**

**electrode nippling system**

device in which electrode strands can be stored or new electrode sections are added

**3.12**

**dog house**

furnace enclosure inside the EAF building close to the EAF

Note 1 to entry: Serves as an indirect fume extraction system and minimizes noise propagation. It is not covered by the scope of this document.

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**3.13****elephant house**

furnace enclosure as part of the EAF building

Note 1 to entry: Serves as an indirect fume extraction system and minimizes noise propagation. It is not covered by the scope of this document.

**3.14****gas cleaning system**

equipment for the collection and processing of created off-gas

**3.15****high current system**

high current connection-line between transformer and electrode

**3.16****trained personnel**

persons with the knowledge of systems, background, experience and ability to operate and/or maintain the equipment in the intended use and proper operation of the machinery/equipment

**3.17****authorized personnel**

trained persons who are nominated by the user to perform a specific task on a specific equipment

**3.18****maintenance**

activities carried out outside the production process

**3.18.1****inspection**

basic checks (e.g. visual) of equipment [ISO 13578:2017](#)

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**3.18.2****service**

periodic exchange of lances, cleaning (e.g. lance, slag door area), lubrication, adjustment of limit switches

**3.18.3****repair**

mending or exchange of damaged components accompanied with complete shutdown (i.e. isolation of energy)

**3.19****safety layout**

graphic overview of the EAF with arrangement of safety-related elements and details

**3.20****manufacturer**

natural or legal person declared as responsible for compliance with the requirements of the design and/or manufacture of machinery

Note 1 to entry: The process of design and construction of machinery may involve several individuals or companies, but one is declared as the manufacturer.

**3.21****safety access**

access into a danger zone by using interlocking guards or trip devices and monitored by the safety control

Note 1 to entry: Definition of interlocking guard and trip device according to ISO 12100:2010, 3.27.4 and 3.28.5.

Note 2 to entry: In general, all hazardous movements are stopped.

3.22

**enabling button**

additional manually actuated device used in conjunction with a start control which, when continuously actuated, permits machine function

[SOURCE: ISO 12100:2010, 3.28.2, modified — The definition has been revised.]

3.23

**hold-to-run control device**

control device which initiates and maintains machine functions only as long as the control device is actuated

[SOURCE: ISO 12100:2010, 3.28.3, modified — The term “control (actuator)” has been changed to “control device”.]

**4 Abbreviated terms**

AC alternating current

DC direct current

EAF electric arc furnace

EBT eccentric bottom tap-hole

DRI direct reduced iron

HBI hot briquetted iron

HMI human machine interface

CCTV closed circuit television

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**5 Significant hazards**

The identified significant hazards and hazardous situations are listed in columns 1 and 2 of [Table 1](#) and are based on a risk assessment, which applies to the equipment listed in the scope. Due to the different designs of EAFs, an individual risk assessment shall be carried out in any case, taking into account the specific characteristics of the EAF in question and the interface between the EAF and other equipment and/or parts of buildings.

**6 Safety requirements and/or measures**

**6.1 General**

**6.1.1 General design requirements**

EAF and equipment conforming to this document shall comply with the safety requirements and/or measures of this subclause.

This document assumes that machinery is used with adequate workplace lighting conforming to ISO 8995-1 or to local regulations.

The manufacturer shall undertake and record design calculations of the structural assembly according to the intended use, e.g. for steel sections, auxiliaries.

Safety devices shall be protected against damage to fulfil the intended function during continuous operation in the respective area.

In particular, the design shall include requirements and constructional details with respect to the following:

- accessibility;
- guards and protection;
- maintenance openings and clearance gaps for cleaning;
- escape routes;
- movement of machinery and material;
- safety during operation;
- safety devices, e.g. hold-to-run control, emergency stop;
- requirements for media systems;
- slag area, e.g. heat protected;
- emergency pit for liquid steel being able to contain the steel volume of the EAF;
- potential environmental conditions, e.g. seismic activities.

#### 6.1.2 Electrical melting power supply

The electrical melting power supply, comprising of the high-voltage switch gear, reactor (if applicable), furnace transformer, AC/DC converters (if applicable) and interconnecting high current systems and cables, shall meet the requirements as defined in IEC 60519-4.

#### 6.1.3 Electrical low-voltage supply and control system

The electrical low-voltage supply, comprising of low-voltage switch gear, control system and low-voltage cables, shall meet the requirements as defined in IEC 60204-1 Edition 6.0.

#### 6.1.4 Bonding and grounding of mechanical furnace parts

To prevent potential differences between mechanical furnace parts, all of these parts shall be bonded and grounded in accordance with IEC 60519-4.

#### 6.1.5 Hydraulic, pneumatic, cooling and lubrication systems

Hydraulic and pneumatic fluid systems and their components shall meet the requirements as defined in ISO 4413 and ISO 4414.

Instruction shall be given in the information for use about systems filled with fluids, which are likely to solidify and/or change viscosity under extreme environmental temperatures and which may cause hazardous situations.

The design of cooling systems, hydraulic and lubrication systems shall consider risks created by temperature and pressure, ignition sources, including fire and toxic effects, as well as gas/dust reactions.

Instructions shall be given how to deal with small and large water leakages inside the furnace. In case of large leakages, indications of the water flow measurement shall be given to the control system to initiate further actions, e.g. stop water flow.

Media, which need to be discharged into dedicated sumps, shall be specified. Equipment which is needed for discharge shall be provided. Instructions for discharge shall be given in the information for use.