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Safety of machinery — Safety requirements for steel converter and associated equipment

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National foreword

This British Standard is the UK implementation of EN 16774:2016.

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

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Sécurité des machines - Prescriptions de sécurité pour les convertisseurs d'acier et les équipements associés

Sicherheit von Maschinen - Sicherheitsanforderungen an Stahlkonverter und zugehörige Einrichtungen

This European Standard was approved by CEN on 27 February 2016.

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European foreword

This document (EN 16774:2016) has been prepared by Technical Committee CEN/TC 322 “Equipments for making and shaping of metals - Safety requirements”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by October 2016, and conflicting national standards shall be withdrawn at the latest by October 2016.

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

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this document.

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 with the means of the document by the above-mentioned stakeholder groups:

— 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.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

This European Standard is a type C standard as stated in EN ISO 12100.

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

This document assumes that

— the converter plant is operated and maintained by adequately trained and competent personnel (see 7.5);

— manual intervention for setting, adjustment and maintenance is accepted as part of the intended use of the plant;

— the plant is used with adequate workplace lighting conforming to EN 12464-1.

This document assumes that the input materials do not contain the following hazardous components:

— radioactive scrap;

— explosives;

— entrapped water/ice;

— closed containers;

— oversized scrap which can lead to water leakage due to collision with lances (see 7.3.5).

The charging should be done to avoid/minimize risk of explosion.

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

1 Scope

This European Standard applies for steel converter and its associated equipment (hereinafter referred to as converter plant) used in the process of carbon or stainless steel making as defined in 3.1 and illustrated in Annex B.

This European Standard deals with significant hazards, hazardous situations and events relevant to the converter plant. It covers the intended use and foreseeable misuse.

This European Standard specifies the safety requirements to be met during transport, assembly, commissioning, operation, maintenance (as described in Clause 5) and decommissioning/disassembly of the equipment.

This European Standard applies to:

Steel converter and its associated equipment for the oxygen steelmaking process

— from hot metal/liquid steel and scrap charging;

— via oxygen refining and stirring;

— temperature measurement and sampling equipment;

— up to tapping including slag retaining device;

— cooling systems;

— maintenance devices (e.g. relining device, tap hole repair device);

— process related interfaces/interactions (e.g. according to design, controls) to

  — media,

  — primary and secondary gas cleaning plant,

  — material feeding systems and ladle alloying systems,

  — transfer cars for steel ladle and slag pot, and

  — charging/tapping equipment, e.g. crane, scrap chute, ladles and slag pots.

This European Standard does not cover safety requirements for:

— usage of process media other than oxygen, nitrogen, argon and compressed air;

— primary and secondary gas cleaning plants;

— measuring devices with radioactive sources;

— material feeding systems and ladle alloying systems;

— transfer cars for steel ladle and slag pot;

— charging/tapping and de-slagging equipment, e.g. crane, scrap chutes, ladles and slag pots;

— auxiliary winches and hoists.

NOTE 1 For variations of converter process where other gases and media, e.g. hydrocarbons, fuels, steam, etc. are used, additional safety measures have to be considered which are not covered in this safety standard

This European Standard is not applicable to converter plant, manufactured before the date of publication of this standard in the Official Journal (OJ).

NOTE 2 In case of revamping, this European Standard can be used as a guideline for the specific parts to be revamped.

2 Normative references

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.

EN 349, *Safety of machinery — Minimum gaps to avoid crushing of parts of the human body*

EN 614-1, *Safety of machinery — Ergonomic design principles — Part 1: Terminology and general principles*

EN 614-2, *Safety of machinery — Ergonomic design principles — Part 2: Interactions between the design of machinery and work tasks*

EN 842, *Safety of machinery — Visual danger signals — General requirements, design and testing*

EN 981, *Safety of machinery — System of auditory and visual danger and information signals*

EN 1037, *Safety of machinery — Prevention of unexpected start-up*

EN 1299, *Mechanical vibration and shock — Vibration isolation of machines — Information for the application of source isolation*

EN 12094-1, *Fixed firefighting systems — Components for gas extinguishing systems — Part 1: Requirements and test methods for electrical automatic control and delay devices*

EN 12464-1, *Light and lighting — Lighting of work places — Part 1: Indoor work places*

EN 14253, *Mechanical vibration — Measurement and calculation of occupational exposure to whole-body vibration with reference to health — Practical guidance*

EN 15004-1, *Fixed firefighting systems — Gas extinguishing systems — Part 1: Design, installation and maintenance (ISO 14520-1:2006, modified)*

EN 60204-1:2006, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements (IEC 60204-1:2005)*

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

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

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

EN 62061:2005, *Safety of machinery — Functional safety of safety-related electrical, electronic and programmable electronic control systems (IEC 62061:2005)*

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

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

EN ISO 4871:2009, *Acoustics — Declaration and verification of noise emission values of machinery and equipment (ISO 4871:1996)*

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

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

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

EN ISO 11202:2010, *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 11202:2010)*

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

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

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

EN ISO 13849-1:2015, *Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design (ISO 13849-1:2015)*

EN ISO 13849-2:2012, *Safety of machinery — Safety-related parts of control systems — Part 2: Validation (ISO 13849-2:2012)*

EN ISO 13850:2015, *Safety of machinery — Emergency stop function — Principles for design (ISO 13850:2015)*

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

EN ISO 14119, *Safety of machinery — Interlocking devices associated with guards — Principles for design and selection (ISO 14119)*

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

EN ISO 14122-1, *Safety of machinery — Permanent means of access to machinery — Part 1: Choice of fixed means of access between two levels (ISO 14122-1)*

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

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

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

EN ISO 14123-1, *Safety of machinery — Reduction of risks to health resulting from hazardous substances emitted by machinery — Part 1: Principles and specifications for machinery manufacturers (ISO 14123-1)*

EN ISO 14123-2, *Safety of machinery — Reduction of risks to health resulting from hazardous substances emitted by machinery — Part 2: Methodology leading to verification procedures (ISO 14123-2)*

EN ISO 19353, *Safety of machinery — Fire prevention and fire protection (ISO 19353)*

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 7000, *Graphical symbols for use on equipment — Registered symbols*

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

3 Terms and definitions

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

NOTE Definitions used in EN and ISO standards referred to in this European Standard are also valid for this document.

3.1
steel converter
tiltable unit for the production of carbon or stainless steel

Note 1 to entry: This tiltable unit is mainly consisting of a vessel with refractory lining, trunnion ring, vessel suspension system, tilting drive.

3.2
associated equipment
additional equipment for the production of carbon steel or stainless steel by means of a steel converter

Note 1 to entry: For associated equipment, e.g. lances, see Figure B.1.

3.3
refining
conversion of hot metal to carbon steel or stainless steel by elimination of (mainly) carbon (and other unwanted elements like silicon, phosphor) using oxygen supply

3.4
refining processes
the processes differ in oxygen supply from top and by injection or in a combination of both; optionally with gas stirring

3.5
production process
all production-related activities between charging to tapping

3.6
maintenance devices
devices to maintain the converter, e.g. relining device, tap hole repair device

3.7
control modes

3.7.1
manual control
every single function/movement will be individually triggered by the operator

3.7.2
automatic control
sequence of serial or parallel functions/movements triggered by the operator

3.8
special control modes
dedicated modes activated by a specific device, to carry out operations like skull removal or slag splashing

3.9
maintenance
all activities carried out outside the production process

3.9.1
inspection
basic checks (e.g. visual) of equipment

3.9.2
service
periodic exchange of lances, cleaning (e.g. lance, converter mouth), lubrication, adjustment of limit switches

3.9.3
repair
repair or exchange of damaged components accompanied with complete shutdown (i.e. isolation of energy)

3.9.4
relining
all activities from shut down of converter for relining up to end of pre-heating (including converter vessel exchange or parts of it, refractory breakout)

3.9.5
skull removal
special procedure for removing the skull inside the converter by using the blowing lance

3.10
ladle
vessel with refractory lining to collect, treat, transport and charge/discharge hot metal/steel

3.11
slag pot
vessel to collect, treat and transport slag

3.12
scrap chute
scrap charging container used to charge scrap into the converter

3.13
work stations
predefined locations for personnel used for production or maintenance activities

3.13.1
operating stations
locations where operating personnel is required during the production process

3.13.1.1
converter control room
main control room in which the control desk and monitoring facilities for a steel converter are located

Note 1 to entry: It is a location where operating personnel is required permanently during the production process.

3.13.1.2
local control stands
control units usually situated adjacent to the equipment

Note 1 to entry: It is a location where operating personnel is required temporarily during the production process, e.g. during charging or tapping.

3.13.1.3
portable control box
mobile control units connected to the control system

Note 1 to entry: For example, to position equipment more precisely.

3.13.2
maintenance points
locations where personnel is required during maintenance

Note 1 to entry: All above-mentioned stations can also be used for maintenance.

3.14
trained personnel
person 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

3.15
authorized personnel
trained person who is instructed by the user to perform a specific task on a specific equipment

3.16
doghouse
enclosure around the converter vessel consisting of sidewalls, ceiling and movable doors (see 5.1.4.4)

Note 1 to entry: The primary purpose is to contain noise and dust during process.

3.17
platforms
areas on different operating levels

Note 1 to entry: For example, for equipment placement and access (see Figure C.1).

3.18
skirt
movable water cooled part of the gas cleaning system

Note 1 to entry: Located above the converter mouth

3.19
protection platform
(re-)movable platform above the converter

Note 1 to entry: Protecting lower areas from falling material.

3.20
protected area
area where persons find protection

3.21
danger zone
hazard zone
any space within and/or around machinery in which a person can be exposed to a hazard

3.22
safety layout
graphical description of plant-related equipment with regard to safety

3.23
warning system
visible, audible warning devices or a combination of both

3.24
blowing-lance
water cooled vertical lance used for blowing technical gases, mainly oxygen

3.25
sub-lance
water cooled vertical lance used for temperature measurement and sampling during blowing

3.26
relining machinery/device
machine for manual or automatic installation of refractory lining inside the converter

Note 1 to entry: Associated lifting, lowering and travelling devices for material transport and access to the workplace are included.

Note 2 to entry: For the associated lifting devices of relining machinery the Directive 95/16/EC on lifts is not applicable (see also Article 24, Point 3, 9th indent of Machinery Directive 2006/42/EC).

4 List of significant hazards

All the significant hazards, hazardous situations and events, as far as they are dealt with in this standard, identified by risk assessment as significant for this type of machinery and which require action to eliminate or reduce the risk are listed in columns 1 and 2 of 5.2, Table 1.

In addition, the manufacturer shall carry out a plant-related risk assessment, including interfaces to auxiliary equipment, according to EN ISO 12100:2010, Clause 4 to identify any other significant hazard of the machine/equipment. Significant hazards identified in this plant-related risk assessment but not dealt with in this standard shall be reduced by applying the principles of EN ISO 12100.

5 Safety requirements and/or measures

5.1 General

5.1.1 Introduction

Converter plants conforming to this European Standard shall comply with the safety requirements and/or measures set out in Clause 5 together with those set out in Annexes A, B and C and the information for use as defined in Clause 7.

Special consideration shall be given to CO emission due to process transients and/or equipment failure.

In general, risks and associated hazards are production and plant-related. The variety of different plants (i.e. different combinations of machines, different boundary conditions) could not be covered in all details in a European Standard. To deal with this fact, an individual risk assessment of the equipment in question shall be carried out (see Clause 4) considering the safety requirements of this European Standard.

The manufacturer shall include in the information for use all details required for a safe operating process under normal operating conditions. He shall also describe the specific safety measures in case of special conditions, e.g. maintenance and adjustment work.

If in addition to the technical measures further measures for risk reduction by organizational precautions according to EN ISO 12100:2010, Clause 5 are necessary, the manufacturer shall include in the Information for use details of this measures and the necessary information considering the residual risks.

5.1.2 Planning phase

The manufacturer shall undertake during planning phase together with the user a layout-check to ensure good placement and safe operation of the converter plant, in particular with regard to:

— position of physical emergency systems;

— accessibility;

— maintenance and cleaning;

— movement of parts of the equipment and material;

— prevention of emissions hazardous to health at the work stations (e.g. avoiding harmful emissions);

— considering ergonomic requirements;

— escape routes.

5.1.3 Safety layout

A safety layout shall be prepared. The aim of the safety layout is to give information (normally by means of one or more drawings) about the physical position of safety related elements at the converter plant.

It is recommended to involve the user of the equipment, e.g. regarding escape routes, fire extinguishing systems, etc.

If applicable, the following shall at least be illustrated:

— areas where the risk of injury due to contact with liquid metal or slag including spraying is given;

— emergency stop buttons;

— escape and access routes (if necessary, e.g. for large plants);

— areas influenced by low oxygen and/or harmful gases (e.g. CO or asphyxiating gases);

— visible/audible warning devices;

— safety related marking;

— safety signs;

— fixed guards (e.g. fences);

— moveable guards (e.g. safety doors);

— light barriers or safety scanners.

The safety layout shall be part of the Instruction for use.

5.1.4 Safety devices and protective measures

5.1.4.1 Safety devices

Safety devices and devices with safety function (e.g. limit switches, locking devices) shall be accessible for maintenance. These devices shall be protected against damage and the possibility of defeating or circumventing in a foreseeable manner (for further details, see EN ISO 14119 and EN ISO 13849-2:2012, Annex D.1 and D.2).

All relevant energy isolating devices, either main or local, shall include facilities to apply one or more padlocks (see EN 1037).

5.1.4.2 Guards

Guards used to prevent access to danger zones shall be selected as appropriate for the degree and frequency of access to be permitted, e.g. an enclosing guard or distance guard, fixed or movable with interlock. This selection shall be made according to EN ISO 14120. Interlock systems shall meet the

requirements of EN ISO 14119 and EN ISO 13849-1 (see 5.1.13). The requirements of the guards shall conform to EN ISO 14120, EN ISO 13857 and EN 349.

As an exception to the requirements of EN ISO 14120, there is no necessity for attaching (e.g. by screws) guards or guarding (e.g. covers) which could be removed only by auxiliary devices (e.g. cranes) due to the heavy weight.

With regard to the safety distances described in EN ISO 13857, the minimum height of distance guards (e.g. perimeter fences, protective structures) shall be 1 400 mm.

5.1.4.3 Guard-rails

Guard-rails are to be considered as means to deter or impede access to hazardous areas, i.e. a physical obstacle which only reduces the probability of access (but does not totally prevent it), offering an obstruction to free access (see EN ISO 12100:2010, 3.29).

Therefore, guard-rails are not permitted as the sole measure of safeguarding hazardous areas in case of significant risks (e.g. from moving machinery or processed product). Guard-rails may only be used for cases where the hazards of slips, trips and falls are involved.

Guard-rails can be used as a measure to prevent unintentional access of unauthorised persons to zones where residual risks exist after more effective risk reduction measures have been used (e.g. zones where equipment with potentially dangerous movements can be operated only in manual mode by means of hold-to-run devices from operating stations with full overview of the driven elements, see 5.1.17 of this standard).

Guard-rails shall conform to EN ISO 14122-3.

5.1.4.4 Doghouse

A doghouse shall be provided to reduce the environmental impact of the process in general (e.g. containing or guiding dust to the dust collection system). As a secondary effect it also reduces the noise level and contains splashes.

It has to be noted that doghouse doors are not guards according to EN ISO 14119 and are not interlocked with the process. In the circumstances where the doghouse doors are not closed (e.g. due to process observation), further production can be continued temporarily if specific instructions and/or additional safety measures like temporary guards have been provided.

Where a doghouse cannot be installed, e.g. for "micro" AOD converters used in foundries (typical capacity less than 25 t), measures like sidewalls, protection shields and removable platforms with protection devices shall be provided.

5.1.4.5 Emergency pit

An emergency pit with the minimum capacity of the entire charge (liquid steel, slag and additions) of the converter shall be provided. It shall be ensured that this pit is kept dry and free of ice.

5.1.4.6 Steel ladle and slag pot

It shall be ensured that the ladle and slag pot has to be dry and free of snow/ice prior to filling with liquid metal/liquid slag to prevent dangerous steam build-up.

5.1.5 Hydraulic, pneumatic, gas, cooling and lubrication systems

Hydraulic, pneumatic, gas, cooling and lubrication systems shall be designed to reduce risks from toxic effects, fire, explosion and noise (e.g. covering and routing of pipes). It does not automatically lead to the usage of low-flammable hydraulic fluids in general.

The systems shall meet the safety requirements as defined in EN ISO 4413 or EN ISO 4414 and considering the requirements specified in Table 1.

5.1.6 Fluid systems carrying or containing fluids

Fluid systems exposed to process hazards, e.g. high temperatures or impacts shall be adequately protected if the damaged fluid systems could cause personal injuries.

Where the risk of fire is given emergency shut-off devices shall be provided. Emergency shut-off devices for the fluid system shall be:

— installed in a safe area outside the danger zone,

— easily accessible, and

— the location shall be clearly indicated.

5.1.7 Fluids not to be discharged to drains

Fluids that have to be discharged into dedicated sumps/containers shall be specified. Instruction for discharge shall be included in the information for use.

5.1.8 Personal protective equipment

The manufacturer shall give information in the information for use (see Clause 7) on the required type of personal protective equipment (PPE).

5.1.9 Warning devices and safety signs

5.1.9.1 Visual and audible danger signals

— Audible warning signals shall be in accordance with EN ISO 7731;

— general requirements, design and testing of visual danger signals shall be in accordance with EN 842;

— system of auditory and visual danger and information signals shall be in accordance with EN 981;

— requirements for indication, marking and actuation shall be in accordance with EN 61310 (all parts);

The information for use shall contain instructions for maintenance of warning devices according to 7.3.6.

5.1.9.2 Safety signs

— Safety signs shall be in accordance with EN ISO 7010,

— design principles for safety signs shall be in accordance with ISO 3864-1,

— design principles for product safety labels shall be in accordance with ISO 3864-2,

— design principles for graphical symbols for use in safety signs shall be in accordance with ISO 3864-3,

— safety way guidance systems shall be in accordance with ISO 16069.

5.1.10 Access

5.1.10.1 Access to a danger zone shall be restricted and therefore shall be protected by guards according to 5.1.4.2 (e.g. lance change area).

Exceptions:

a) Guards preventing/hindering traffic cannot be installed on converter platform, because trained personnel need access free from obstacles to perform different operations very frequently with machines.

b) Guards cannot be installed on ground floor in the converter area (see Figure C.1), because trained personnel need access to perform different operations very frequently with machines.

5.1.10.2 In order to allow authorized personnel safe access to and stay in areas protected by movable interlocked guards, adequate technical safety measures shall be applied as follows:

a) Access conditions

   All sources of energy causing a danger inside a danger zone shall be in a safe condition (e.g. movements and media flows are stopped);

b) Conditions for staying/working

   Hazardous movements inside a danger zone shall only be permitted with a hold-to-run control device and by using an enabling button and if necessary at reduced speed;

c) Conditions for restart

   See 7.3.5.1 h).

5.1.10.3 Access to control desks, converter control rooms, underground areas, inspection and service floors shall be in accordance with EN ISO 13857, EN ISO 14122-1 to EN ISO 14122-4.

5.1.10.4 Guard-rails shall be in accordance with 5.1.4.3.

5.1.10.5 Surfaces of walkways and stairs shall have slip-resistant surfaces according EN ISO 14122-3.

5.1.10.6 The required performance level (PLr) in relation to the category of safety related parts of the control systems for access to equipment during operation or maintenance shall be selected according to Annex A; A.2 and/or 5.2 (Table 1) and shall consider the requirements of EN ISO 14119 and EN 1037.

5.1.10.7 Accessible rotating/moving parts like drive shafts, couplings, belts and chains, pulleys and sprockets, i.e., where the safety distances in EN ISO 13857 cannot be met, shall be guarded in accordance with EN ISO 14120. Rotating shafts should be marked so that it is visually evident when the shafts are in motion.

5.1.10.8 Safety signs shall be in accordance with 5.1.9.2.

5.1.11 Escape routes

The design of escape routes is not harmonized. Therefore, the national regulations should be followed.

Escape routes should meet the following minimum requirements:

— two exits which shall be located as distant as possible from each other or in conformity with the local requirements (for small rooms, e.g. local control stand for tapping and charging it may not be applicable);

— opening of doors in direction of escape route;

— emergency lighting;

— signs shall indicate the escape routes;

— free from obstacles.

5.1.12 Electrical equipment

Electrical equipment shall conform to EN 60204-1. In particular, the manufacturer shall design and install all electrical equipment so that it is capable of withstanding all hazards, including those from heat, vibration, wet conditions, identified in the risk assessment and taking into account the requirement set out in Annex A.

5.1.13 Safety related control system

Safety related controls shall be selected in accordance with the risk assessment and as described in the EN ISO 13849- series. A minimum requirement is defined in A.2 of Annex A. For significant hazards requiring a safety related control system, the quality of such a system is provided as a combination of PLr and category (see Table 1). In cases where the supporting data for documentary proof of category from the manufacturer of such a component is not available the fulfilment of the PLr is sufficient. For electro-mechanical components, e.g. contactor, relay, etc., category 3 is mandatory where PLr = d is required.

Wherever it is necessary to use SIL certified equipment in accordance to EN 61511-1, for safety-systems in accordance to EN ISO 13849, the following procedure should be used:

a) By selecting the lambda values (λd, λdd, etc.), given in the safety data sheet of the equipment, the probability of dangerous failure per hour (PFHd) shall be calculated, considering the hardware fault tolerance as well as the system architecture, given in EN 62061:2005, 6.7.8.2.

b) With the calculated value the corresponding performance level shall be selected by using Table 3 of EN ISO 13849-1:2015.

5.1.14 Surface temperatures and heat radiation

Surfaces which are hot in operation and where the risk to be touched is given, shall be designed, positioned or provided with, e.g. thermal guards, so that the burn threshold is not exceeded concerning the contact time and material as specified in EN ISO 13732-1.

Where a risk by heat radiation is given during operation, protection walls/shields with isolating material shall be provided.

5.1.15 Ergonomics

Ergonomic design principles of EN 614-1 and EN 614-2 shall be considered. Particular attention shall be paid to the following:

— dedicated lifting aids or anchoring points for common lifting devices shall be provided whenever frequent lifting or heavy tooling of machines is required;

— eyebolts or similar aids shall be fitted to heavy components to lift them; they shall also be fitted with handles, hand-holds or grips with a slip-resistant (e.g. knurled) surface;

— work areas where manual handling of components has to be carried out frequently shall be designed so that they are free of obstructions and that the operator is not hindered in his movements;

— access to components requiring a regular maintenance shall be in accordance to 5.1.10;

— slip-resistant surfaces according to 5.1.10.5;

— vibration protection according to 5.1.24;

— heat protection according to 5.1.14;

— in case of regular maintenance: spatial arrangement of electric junctions, electrical connections and devices shall be in accordance with EN 60204-1. For fluid connections/junctions (e.g. valves) the location should be at best between 400 mm and 1 800 mm above operators standing level.

NOTE There are areas and activities in which the ergonomic principles can be implemented only partially (e.g. AOD converter exchange).

5.1.16 Fire protection

The necessity for installing a fire protection system at steel converters (e.g. converter control room, hydraulic/electric rooms) shall be reviewed considering the process conditions (e.g. use of lubricants). For detailed information, see EN 12094-1, EN ISO 19353, EN 15004-1.

Hydraulic systems exposed to liquid steel shall be provided with separate systems for fire protection (e.g. covers, small tanks, low flammable fluids) or other means shall be provided to reduce the risk of fire.

The national regulations and the requirements of the insurance companies have to be considered.

5.1.17 Operating stations for the steel converter

5.1.17.1 General

Provide escape routes according 5.1.11.

The operating stations shall be designed so that frequently used controls are located in an ergonomic reach.

Visual displays shall be so arranged that they are free of reflections and unambiguous to be identified.

Good visibility from the operator's position to the triggered operating process shall be ensured. If necessary, visual aids (e.g. CCTV, mirrors) shall be provided.

5.1.17.2 Converter control room

The converter control room shall be designed taking into consideration the ergonomic principles of EN ISO 11064-1.

If applicable, the converter control room shall be

— equipped with automatically controlled air condition;

— thermal-insulated;

— sound-insulated (see 5.1.22.4);

— equipped with heat reflecting windows;

— equipped with special coloured glass areas to protect operators eyes against radiation light;

— protected against external effects by, e.g. slag and steel splashes, where the risk is given.

5.1.17.3 Local control stand

A local control stand shall be in accordance with EN 60204-1.

The local control stand (i.e. a temporary work place) shall be protected against radiated heat, external impact (e.g. by slag and steel splashes), dust and noise, if necessary.

5.1.18 Portable wireless control box

A portable wireless control box shall be in accordance with EN 60204-1:2006, 9.2.7.

A portable wired control box shall be treated as a local control stand when applying EN 60204-1.

5.1.19 Loss of energy

In case of hazardous situations due to loss of energy (hydraulic, pneumatic, electric) all components shall go into or stay in a defined safe position and/or safe state.

In case of re-supply of energy after interruption, any uncontrolled re-start shall be avoided, see EN 1037.

The control systems and devices shall meet the requirements of EN 60204-1:2006, 7.5 and 9.4.3.2 as well as EN ISO 13849-1:2015, 5.2.8.

In case of loss of energy special instructions for actions to be taken shall be given in the information for use.

5.1.20 Areas with specific hazards

For areas with the risk of ignition, toxic effects, gas/dust accumulation or asphyxiation,, specific action shall be taken (e.g. ventilation, removal of dust, fixed or mobile gas monitoring devices), considering the requirements of EN ISO 14123-1 and EN ISO 14123-2.

For areas with the risk of unexpected flame propagation or splashing of molten material, specific instruction shall be provided.

For areas where the risk of artificial optical radiation (e.g. infrared) exists, information shall be given in the information for use.

5.1.21 Cooling water systems

The function of the cooling water system shall be monitored and malfunctions during operation shall be indicated at least by a warning system (see 5.1.9).

Special instructions for actions to be taken in case of emergency shall be given in the information for use.

5.1.22 Noise

5.1.22.1 General

Noise emitted by a plant is a significant hazard.

Noise can arise from several sources in a plant e.g. such as those listed in 5.1.22.2. Means shall be applied to reduce the noise levels (e.g. according 5.1.22.3, 5.1.22.4 and 5.1.22.5).

For noise measurement requirements, see Annex C.

5.1.22.2 Noise sources

The main noise sources of a steel converter during process are:

— blowing process;

— scrap charging;

— alloy addition (especially during tapping).

5.1.22.3 Noise reduction at source by design

When designing a machine, methodology and technical measures for reducing noise at source at the design stage shall be considered, see EN ISO 11688-1. Examples of general measures which should be considered are:

— reduce impact energy (e.g. by reducing the height of fall);

— reduce power of impact (e.g. by damped impact);

— reduce noise of gas flow (e.g. low-noise nozzles, sound absorbers);

NOTE 1 Due to functional reasons, noise reduction is not applicable for oxygen lances, because supersonic speeds are necessary for efficient penetration of oxygen into the steel bath.

— reduce noise of water flow;

— use internal attenuation (e.g. cast instead of steel plate structures, sandwich plate);

— dampening of structure-borne noise (e.g. by coating or sandwich plate);

— insulation of structure-borne noise (e.g. by installation of masses), vibration isolated mounting (e.g. by spring elements and dampers);

— acoustic short circuit (e.g. perforated plate/lattice boxes).

The criterion for assessing the efficacy of measures to reduce noise at source is the actual noise emission value from the machine in relation to other machines of the same family and not the nature of the measures themselves.

NOTE 2 EN ISO 11688-2 gives useful information on noise generation mechanisms in machinery.

5.1.22.4 Noise reduction by protective measures

The secondary noise control can be achieved, e.g. by the increase of noise dampening and insulation, physical separation for noise source and receiver, sound-insulated control rooms, separate rooms/cellars for hydraulic pumps and water distribution systems. Examples are reductions by using:

— total or partial enclosures;

— shields;

— silencers;

— increased distance between source and operator.

NOTE The efficacy of such protective measures can be estimated, e.g. by using EN ISO 11546-1 (for enclosures), EN ISO 11691 and EN ISO 11820 (for silencers) and EN ISO 11821 (for shields).

5.1.22.5 Noise reduction by information

If noise reduction at source and/or by protective measures is not sufficient, further protection of the operator is necessary. For recommendations to the user see 7.3.5.1 f).

5.1.23 Vibrations

Vibrations shall be considered at the design stage, see EN 1299.

Harmful hand-arm vibration at converters during the process is not expected.

Where the risk of whole-body vibration is given, measurement according to EN 14253 shall be made.

5.1.24 Linked Equipment

For the equipment linked to a steel converter, e.g. media supply systems, primary and secondary gas cleaning plant, material handling systems respective instructions and safety measures including monitoring requirements for the take-over-points shall be given in the information for use (see 7.3.3 g).

5.1.25 Hold-to-run control device and enabling button

5.1.25.1 A hold-to-run control device shall meet the requirements of EN 60204-1. The operator using a hold-to-run control device shall have good visibility over the danger zone (see 5.1.17), e.g. by closed circuit television.

5.1.25.2 An enabling button shall meet the requirements of EN 60204-1. Release of an enabling button shall bring the movement to standstill. The performance level shall be corresponding to the related function.

5.1.26 Mechanical restraint devices

Mechanical restraint devices shall be selected depending on the design, e.g. safety bolts, latches, scotches or brakes.

Safety bolts operated automatically, e.g. by hydraulic cylinders, shall be monitored by the control system in their designated protecting positions.

Where safety bolts or latches are to be set by hand they shall be clearly identifiable and installed directly on the equipment to be protected (e.g. with a chain).

Brakes shall release only when energised and shall brake mechanically when de-energised, e.g. by spring suspended system (e.g. brakes of tilting drive and lances).

5.1.27 Safety related Software

Safety related software shall be protected against unauthorised access and manipulation, e.g. by passwords on different levels. Password(s) can be forwarded to the user, but only on a confidential basis. The Information for use shall point out, that changes of the safety-related software and/or parameters may lead to new hazards.

For safety requirements regarding software, see EN ISO 13849-1:2015, 4.6.

NOTE Software changes can be detected with the checksum. If the original checksum is not conforming to the actual checksum, an unauthorized software manipulation must be assumed.

5.2 List of significant hazards, hazardous situations, safety requirements and/or measures

5.2.1 Structure of Table 1

Table 1 is developed to allow the designer and manufacturer of the equipment to apply a logical approach for checking the design against the list of significant hazards with respect to steel converter.

Table 1 is structured as follows:

— column 1 identifies the significant hazards;

— column 2 describes the hazardous situations;

— column 3 specifies the safety requirements and/or measures to avoid or minimize the hazards and hazardous situations. They are shown as combined measures or as options;

— column 4 makes reference to the relevant clauses or standards defining the measures. All references shown are applicable to each of the measures except where this is otherwise indicated;

NOTE When implementing safety requirements and/or measures it should be considered that different hazards may appear at the same time.

— column 5 identifies the verification methods to be used to demonstrate conformity. Basis of these are, e.g. drawings, functional descriptions and/or calculations. The abbreviations of the intended verification methods D (Drawings and/or calculations), V (visual), T (test/check) and M (measurement) are defined as follows:

D: Drawings and/or calculations verify that the design characteristics of the components provided meet the requirements

V: Visual inspection verifies the required features of the components

T: A test/check verifies that the features provided perform their function in such a way that the requirement is met

M: Measurement to verify that requirements are met to the specified limits and including advice in the information for use

Table 1 — List of significant hazards, hazardous situations safety requirements and/or measures

Significant hazard	Hazardous situation	Safety requirements and/or measures	Reference	Verification
5.2.2 General hazards in the converter area				
1 Fire	1.1 Contact of liquid steel with hydraulic fluids	1.1.1 Measures to avoid hydraulic system exposure to liquid steel and	5.1.16 5.1.5	D, V
	1.2 High thermal radiation	1.2.1 Hydraulic system exposed to high thermal radiation shall be covered	5.1.16	D, V
	1.3 Oxygen saturation	1.3.1 Avoidance of enclosed rooms or		D, V
		1.3.2 Provide monitoring system and		D, V, T
		1.3.3 Operating/maintenance instructions	7.3.5 7.3.6	V
2 Combination of hazards	2.1 Unexpected movement out of a hold position	2.1.1 Mechanical restraining devices shall be provided where equipment has to be held in a defined position and the risk of unexpected movement is given	5.1.26	D, V, T
	2.2 Ejection of hot metal, liquid steel, slag and solids due to reactions in the converter:			

Significant hazard	Hazardous situation	Safety requirements and/or measures	Reference	Verification
	— due to moisture, water, ice and other fluids in input material	2.2.1 Operating/maintenance instructions: e.g. check for water or ice in scrap, check moisture content in flux and alloy material, exclude all hollow parts in scrap which could contain fluids	7.3.5.1 k)	V
	— leakage from water cooled equipment (e.g. lance, trunnion ring, top cone)	2.2.2 Design of equipment	5.1.15	D, V, T
	— leakage from piping system	2.2.3 Operating/maintenance instructions: supervision of leakages		D, V
	— slopping	2.2.4 to be considered in design of equipment, e.g. provision of a doghouse	5.1.4.4	D, V
	2.3 Presence of personnel at ground floor below converter	2.3.1 Warning signs and	5.1.9	V
		2.3.2 Operating/maintenance instructions: Personnel is not allowed to enter this area, except after explicit permission (e.g. after skull removal)	7.3.5	V
3 Gases (toxic, asphyxiation)	3.1 Presence of CO	3.1.1 Operating/maintenance instructions: use CO warning device	7.3.5.1 c)	V
	3.2 Hazardous gas concentration in enclosed gas valve station rooms	3.2.1 Avoidance of enclosed rooms or		D, V
		3.2.2 Provide ventilation and		D, V
		3.2.3 Monitoring system and		D, V, T
		3.2.4 Visual and audible warning at the entrance and in the room and	5.1.9.1	D, V, T
		3.2.5 Operating/maintenance instructions: PPE	7.3.5.1 c)	V
4 Noise	4.1 Exposure to noise with the risk of deafness, physiological disorders, accidents due to the non-perception of acoustic signals	4.1.1 Noise reduction at work stations and	5.1.22 Annex C	D, M
		4.1.2 Operating/maintenance instructions	7.3.5.1 f)	V
5 Vibration	5.1 Exposure to hand-arm and whole body vibration	5.1.1 Vibration reduction at work stations and	5.1.23	D, M
		5.1.2 Operating/maintenance instructions	7.3.5.1 g)	V
5.2.3 Process				
5.2.3.1 Charging process				
1 Impact	1.1 Ground floor and converter platform: ejecting/falling of scrap pieces during scrap charging	1.1.1 Visual and audible warning device and	5.1.9	D, V, T
		1.1.2 Marking of the danger zones in the safety layout and	5.1.3	D, V
		1.1.3 Operating/maintenance instructions: PPE and/or	7.3.5.1 c)	
		1.1.4 See 5.2.2, hazardous situation 2.2	5.2.2	
2	2.1 Ground floor and	2.1.1 Visual and audible warning device and	5.1.9.1	D, V, T

Significant hazard	Hazardous situation	Safety requirements and/or measures	Reference	Verification
Burns	converter platform: hot metal/liquid steel/slag ejection/spraying during charging	2.1.2 Marking of the danger zones in the safety layout and	5.1.3	D, V
		2.1.3 Operating/maintenance instructions: PPE and/or	7.3.5.1 c)	V
		2.1.4 See 5.2.2, hazardous situation 2.2	5.2.2	
3 Burns, impact	3.1 Crane operation: ejecting/falling of scrap pieces during scrap charging and/or hot metal/ liquid steel/slag ejection/spraying during and after hot metal charging	3.1.1 Operating/maintenance instructions: take care of the placement of the crane operator's location (e.g. cabin)		D, V
4 Combination of hazards	4.1 Dust and fumes	4.1.1 Operating/maintenance instructions: inform the user about the necessity of dust/fume removal measures	7.3.5.1	V
5.2.3.2 Blowing process including automatic measurement from top				
1 Fire	1.1 Oxygen release outside the converter vessel	1.1.1 Valve opens only when the lance is at a position where the complete oxygen stream can only be released into the converter vessel. Provide safe control: PLr = d in conjunction with category 3 according to EN ISO 13849-1:2015 and	5.1.13	D, T, M
		1.1.2 Operating/maintenance instructions	7.3.5	V
2 Combination of hazards	2.1 Oxygen lance or sub-lance damaged due to collision with the vessel. Regarding possible water leakage into the liquid metal, see 2.2 below	2.1.1 Converter shall be in blowing position (blowing position tolerance to be defined according to design) to release lance movement towards the converter. Provide safe control: PLr = d in conjunction with category 3 according to EN ISO 13849-1:2015 and	5.1.13	D, T, M
		2.1.2 Lances shall be at a safe height to release converter tilting. Provide safe control: PLr = d in conjunction with category 3 according to EN ISO 13849-1:2015 and	5.1.13	D, T, M
		2.1.3 Operating/maintenance instructions	7.3.5	V
	2.2 Water leakage of oxygen lance or sub-lance cooling systems	2.2.1 Detection of water leakage. Provide safe control with at least: PLr = d in conjunction with category 3 according EN ISO 13849-1:2015 and	5.1.13	D, T, M
		2.2.2 Isolate the water source. Provide safe control: PLr = d in conjunction with category 3 according to EN ISO 13849-1:2015 and	5.1.13	D, T, M
		2.2.3 Lances shall be removed. To ensure this function a back-up system shall be provided and		D, V, T

Significant hazard	Hazardous situation	Safety requirements and/or measures	Reference	Verification
		2.2.4 Isolate the oxygen source. Provide safe control: PLr = d in conjunction with category 3 according to EN ISO 13849-1:2015 and	5.1.13	D, T, M
		2.2.5 Flow rate of bottom stirring/blowing medium shall be reduced to a converter specific minimum and		D, T, M
		2.2.6 Operating/maintenance instructions	7.3.5	V
	2.3 Blow-interruption request from other systems	2.3.1 Lances shall be removed. To ensure this function a back-up system shall be provided and		D, T
		2.3.2 Isolate the oxygen source. Provide safe control: PLr = d in conjunction with at least category 3 according to EN ISO 13849-1:2015 and	5.1.13	D, T, M
		2.3.3 In case of water leakage: Flow rate of bottom stirring/blowing medium shall be reduced to a converter specific minimum and		D, T, M
		2.3.4 Operating/maintenance instructions	7.3.5	V
5.2.3.3 Manual temperature measurement and sampling				
1 Burns	1.1 Manual temperature measurement and sampling	1.1.1 Adequately sized and protected (e.g. chain curtain) opening in doghouse door or protection shield and		D, V
		1.1.2 Operating/maintenance instructions: PPE	7.3.5.1 c)	V
2 Impact	2.1 Falling skull	2.1.1 Provide safety device, e.g. doghouse or movable protection shield and	5.1.4.4	D, V
		2.1.2 Operating/maintenance instructions	7.3.5	V
3 Falling	3.1 Falling from converter platform due to temporary malfunction of dog house doors	3.1.1 Operating/maintenance instructions: Provide temporary safeguarding	7.3.6	V
5.2.3.4 Tapping/deslagging process				
1 Burns, heat radiation, impact	1.1 At converter platform in case using slag retaining devices (e.g. slag ball or slag dart systems)	1.1.1 Adequately sized and protected (e.g. chain curtain) opening in doghouse door or doghouse door has to be opened minimally and		D, T
		1.1.2 Visual and audible warning devices and	5.1.9.1	D, V
		1.1.3 Operating/maintenance instructions: PPE	7.3.5.1 c)	V
	1.2 At ground floor below converter (see Figure C.1)	1.2.1 Warning devices and	5.1.9.1	D, V
		1.2.2 Operating/maintenance instructions	7.3.5	V

Significant hazard	Hazardous situation	Safety requirements and/or measures	Reference	Verification
2 Combination of hazards	2.1 Reaction of liquid steel and moisture in emergency pit	2.1.1 Operating/maintenance instructions: emergency pit shall be kept dry and free of ice/snow	7.3.5	V
	2.2 Reaction of liquid steel and moisture in steel ladle or slag pot	2.2.1 Operating/maintenance instructions: steel ladle and slag pot shall be kept dry and free of ice/snow	7.3.5	V
	2.3 Unexpected movement during tapping	2.3.1 Unexpected movement of converter shall be avoided. Provide safe control: PLr = d in conjunction with at least category 3 according to EN ISO 13849-1:2015 and	5.1.13	D, T
		2.3.2 Operating/maintenance instructions	7.3.5	V
	2.4 Manual movement during tapping	2.4.1 Manual movement only by hold-to-run control with enabling button. Provide safe control: PLr = d in conjunction with at least category 3 according to EN ISO 13849-1:2015 and	5.1.13 5.1.25	D, T, M
		2.4.2 Operating/maintenance instructions	7.3.5	V
	2.5 Unintentional start of automatic movement during tapping	2.5.1 The automatic movement shall not be started unintentionally. Provide safe control of the automatic movement: PLr = d in conjunction with at least category 3 according to EN ISO 13849-1:2015 and	5.1.13	D, T, M
		2.5.2 Operating/maintenance instructions	7.3.5	V
5.2.4 Equipment				
5.2.4.1 Lance, sub-lance and manipulator				
1 Crushing	1.1 Unexpected movement of lance/sub-lance	1.1.1 Provide guards with interlocked doors and	5.1.10.8	D, T, V
		1.1.2 Unexpected vertical movements shall be avoided. Provide safe control: PLr = d in conjunction with at least category 3 according to EN ISO 13849-1:2015 and	5.1.13	D, T
		1.1.3 Unexpected horizontal movements shall be avoided. Provide safe control: PLr = c in conjunction with at least category 1 according to EN ISO 13849-1:2015 in combination with reduced speed of < 5 m/min and	5.1.13	D, T
		1.1.4 Operating/maintenance instructions	7.3.5	V
	1.2 Unexpected movement of sub-lance manipulator	1.2.1 Provide guards with interlocked doors and	5.1.10.8	D, T, V
		1.2.2 Unexpected movements shall be avoided. Provide safe control: PLr = d in conjunction with at least category 3 according to EN ISO 13849-1:2015 and	5.1.13	D, T
		1.2.3 Operating/maintenance instructions	7.3.5	V

Significant hazard	Hazardous situation	Safety requirements and/or measures	Reference	Verification
2 Combination of hazards	2.1 Entrapment of leakage water in liquid steel or slag	2.1.1 Detection of water leakage. Provide safe control: PLr = d in conjunction with at least category 3 according to EN ISO 13849-1:2015 and	5.1.13 2.2.1 of 5.2.3.2	D, V, T, M
		2.1.2 Isolate the water source. Provide safe control: PLr = d in conjunction with at least category 3 according to EN ISO 13849-1:2015 and	5.1.13 2.2.2 of 5.2.3.2	D, V, T
		2.1.3 Operating/maintenance instructions	7.3.5	V
	2.2 Use of lance for preheating	2.2.1 Valve opens only when the lance is at a position where the complete oxygen stream can only be released into the converter vessel. Provide safe control: PLr = d in conjunction with category 3 according to EN ISO 13849-1:2015 and	5.1.13 5.2.3.2	D, T, M
		2.2.2 Converter shall be in blowing position (blowing position tolerance to be defined according to design) to release lance movement to the converter. Provide safe control: PLr = d in conjunction with category 3 according to EN ISO 13849-1:2015 and	5.1.13	D, T, M
		2.2.3 Operating/maintenance instructions	7.3.5	V
5.2.4.2 Slag retaining device (dart/ball system) NOTE Converter vessel mounted slag retaining systems do not cause any hazard at the converter platform (e.g. slag stopper, slide gate systems).				
1 Crushing	1.1 Movements of the slag retaining device at converter platform	1.1.1 Unexpected movements shall be avoided. Provide safe control: PLr = d in conjunction with at least category 3 according to EN ISO 13849-1:2015 and	5.1.13	D, T
		1.1.2 Manual movement only by hold-to-run control with enabling button. Provide safe control: PLr = d in conjunction with at least category 3 according to EN ISO 13849-1:2015 and	5.1.13	D, T
		1.1.3 Full overview over the danger zone and	5.1.10.1	V
		1.1.4 Visible and audible warning and	5.1.9.1	D, V
		1.1.5 Operating/maintenance instructions	7.3.5	V
5.2.4.3 Steel converter				
1 Combination of hazards	1.1 Leakage of converter cooling (trunnion ring or top cone cooling) can lead to water in ladle, slag pot and emergency pit (see also 5.2.3.4)	1.1.1 Detection of water leakage. Provide safe control: PLr = d in conjunction with at least category 3 according to EN ISO 13849-1:2015 and	5.1.13 2.2.1 of 5.2.3.2	D, T,
		1.1.2 Isolate the water source. Provide safe control: PLr = d in conjunction with at least category 3 according to EN ISO 13849-1:2015 and	5.1.13 2.2.2 of 5.2.3.2	D, T

Significant hazard	Hazardous situation	Safety requirements and/or measures	Reference	Verification
		1.1.3 Operating/maintenance instructions	7.3.5	V
	1.2 Falling of water cooled systems not directly welded to the converter resulting in contact with liquid steel or slag, e.g. panels, boxes	1.2.1 Water cooled systems fixed mechanically to the converter shall in addition have a restraining device, e.g. chain	5.1.26	D, V
		1.2.2 Operating/maintenance instructions	7.3.5	V
	1.3 Unexpected movement of converter vessel due to control failure, e.g. in case of lance inside converter	1.3.1 Unexpected movements shall be avoided. Provide safe control: PLr = d in conjunction with at least category 3 according to EN ISO 13849-1:2015	5.1.13	D, T
	1.4 Unexpected movement of converter vessel in tilted position due to, e.g. brake failure, gear box failure	1.4.1 Brake system shall be designed that despite the failure of one brake the converter is held in position and	5.1.26	D, T
		1.4.2 It shall be ensured that for defined conditions (e.g. maximum designed capacity of the vessel, mass of the skull) the converter has a self-uprighting tendency during normal operation and		D
		1.4.3 Because skulls in mouth and top cone area are part of the normal operation, the design shall consider the total weight of the skulls limited to 15 % (or another mutually agreed value) of the nominal tonnage and		D
		1.4.4 Torque measurement shall be implemented to provide the operator with a warning before the defined conditions are exceeded and		D, T, M
		1.4.5 Operating/maintenance instructions: Any modification of the converter vessel shall maintain these conditions	7.3.5	V
2 Crushing	2.1 During movement of doghouse doors	2.1.1 Movement of doghouse doors with a maximum speed of 45 m/min and		D, M
		2.1.2 Hold-to-run control and full overview over the danger zone or	5.1.25	D, T
		2.1.3 Collision prevention devices, e.g. safety bumper, fence, light barrier and		D, V
		2.1.4 Audible or visible warning before start-up and during movement and	5.1.9	D, V, T
		2.1.5 Operating/maintenance instructions	7.3.5	V
5.2.4.4 Converter exchange equipment				
1 Combination of hazards	1.2 Unexpected movements (e.g. exchange car, hydraulic clamps)	1.2.1 Unexpected movements shall be avoided. Provide safe control: PLr = c in conjunction with at least category 1 according to EN ISO 13849-1:2015 and	5.1.13	D, T
		1.2.2 Hold-to-run control and enabling	5.1.25	D, T

Significant hazard	Hazardous situation	Safety requirements and/or measures	Reference	Verification
		button and with full overview over the danger zone and		
		1.2.3 Operating/maintenance instructions	7.3.5	V
5.2.4.5 Moveable platform between the converter mouth and off-gas duct				
1 Combination of hazards	1.2 Unexpected movement of protection platform	1.2.1 Unexpected movements shall be avoided. Provide safe control: PLr = c in conjunction with at least category 1 according to EN ISO 13849-1:2015 and	5.1.13	D, T
		1.2.2 Hold-to-run control and enabling button and with full overview over the danger zone and	5.1.25	D, T
		1.2.3 Operating/maintenance instructions	7.3.5	V
5.2.5 Specific requirements for interfaces				
5.2.5.1 Interface to cranes				
1 Combination of hazards	1.1 Movements of cranes in the converter area	1.1.2 Operating/maintenance instructions: cranes should be equipped with visible and audible warning devices; adequate warning should be given before starting an operation in the converter area, if necessary	7.3.5	V
5.2.5.2 Interface to media				
1 Fire	1.1 Uncontrolled opening of oxygen valves	1.1.1 Uncontrolled opening shall be avoided and		D, T
		1.1.2 Safe closing of oxygen valve shall be ensured. Provide safe control: PLr = d in conjunction with at least category 3 according to EN ISO 13849-1:2015 and	5.1.13 2.2.4 of 5.2.3.2	D, T
		1.1.3 Operating/maintenance instructions	7.3.5	V
	1.2 Leakage of oxygen through the pipeline due to valve leakage	1.2.1 Design to avoid leakage, e.g. double isolation of oxygen with block and bleed function		D, V
	1.3 Leakage of oxygen from pipes and valve bodies, flanges etc.	1.3.1 Operating/maintenance instructions: inspection to detect and measures to avoid leakages	7.3.6	V
2 Combination of hazards	2.1 Entrapment of leakage water in liquid steel or slag due to mixing by oxygen stream	2.1.1 Safe closing of oxygen valve shall be ensured. Provide safe control: PLr = d in conjunction with at least category 3 according to EN ISO 13849-1:2015 and	5.1.13 2.2.4 of 5.2.3.2	D, T
		2.1.2 Operating/maintenance instructions	7.3.5	V
5.2.5.3 Interface to primary and secondary gas cleaning plant/gas recovery system				
1 Combination of hazards	1.1 Collision of converter and skirt	1.1.1 Detection of safe position of skirt for tilting of converter. Provide safe control: PLr = d in conjunction with at least category 3 according to EN ISO 13849-1:2015	5.1.13	D, V, T

Significant hazard	Hazardous situation	Safety requirements and/or measures	Reference	Verification
	1.2 Failure of the primary or secondary gas cleaning plant or gas recovery system to generate blow-stop request	1.2.1 Blow-stop shall be ensured with PLr = d in conjunction with at least category 3 according to EN ISO 13849-1:2015	5.1.13	D, T
	1.3 Unintended release for blowing from primary/secondary gas cleaning or gas recovery system	1.3.1 Release for blowing shall be ensured with PLr = d in conjunction with at least category 3 according to EN ISO 13849-1:2015	5.1.13	D, T
5.2.5.4 Interface to material feeding systems and ladle alloying systems				
1 Impact	1.1 Falling of material onto the converter platform	1.1.1 Release of material discharge only if converter is in upright position or doghouse doors are closed and		D, V
		1.1.2 Provide safe control: PLr = c in conjunction with at least category 1 according to EN ISO 13849-1:2015	5.1.13	D, T
2 Toxic gas, fire	2.1 Escape of carbon monoxide and flames from converter	2.1.1 Provide measures against escape of carbon monoxide and		D, V
		2.1.2 Provide safe control for release of blowing. PLr as per risk assessment of material feeding systems and ladle alloying systems	5.1.13	D, T
5.2.6 Maintenance (service and inspection during process)				
5.2.6.1 Cleaning of lance and sub-lance				
1 Combination of hazards	1.1 Unexpected movements in lance cleaning area during blowing breaks	1.1.1 Unexpected movements in lance cleaning area shall be avoided. Provide safe control, see 5.2.4.1 and	5.2.4.1	D, T
		1.1.2 Safe release for lance hoist movement only from cleaning desk and		D, T
		1.1.3 Shut-off oxygen supply for the lance (see 5.2.3.2, 1.1) and	5.2.3.2.1	D, T
	1.2 Dust generation	1.2.1 Interlock material discharge for steel converter (see 5.2.5.4; 1.1.2) and		D, T
		1.2.2 Operating/maintenance instructions	7.3.5	V
	1.3 Falling skull due to lance cleaning	1.3.1 Operating/maintenance instructions: Protection of lower areas, e.g. doghouse shall be closed or converter in upright position or movable protection shield on the converter platform	7.3.5	V

Significant hazard	Hazardous situation	Safety requirements and/or measures	Reference	Verification
5.2.6.2 Tap hole repair				
1 Combination of hazards	1.1 Unexpected movement of converter	1.1.1 Unexpected movement of converter shall be avoided. Provide safe control: PLr = d in conjunction with at least category 3 according to EN ISO 13849-1:2015 and	5.1.13	D, T
		1.1.2 Operating/maintenance instructions	7.3.5	V
	1.2 Movement of converter	1.2.1 Movement of converter shall only be initiated by hold-to-run control and enabling button from local control stand and	5.1.25	D, T
		1.2.2 Operating/maintenance instructions	7.3.5	V
5.2.6.3 Converter mouth and slag protection cleaning				
1 Combination of hazards	1.1 Unexpected movement of converter	1.1.1 Unexpected movement of converter shall be avoided. Provide safe control: PLr = d in conjunction with at least category 3 according to EN ISO 13849-1:2015 and	5.1.13	D, T
		1.1.2 Operating/maintenance instructions	7.3.5	V
	1.2 Movement of converter	1.2.1 Movement of converter shall only be initiated by hold-to-run control and enabling button from local control stand and	5.1.25	D, T
		1.2.2 Operating/maintenance instructions	7.3.5	V
5.2.6.4 Skull removal inside converter				
1 Combination of hazards	1.1 Use of lance for skull removal in upright or preselected tilted position	1.1.1 Provide skull removal operation mode covering the following conditions:		
		— Valve opens only when the lance is at a position where the complete oxygen stream can only be released into the converter vessel. Provide safe control: PLr = d in conjunction with category 3 according to EN ISO 13849-1:2015 and	5.1.13	D, T
		— Converter shall be either in upright position or tilted to a preselected angle (as per design) to release lance movement to the converter without the risk of collision with the converter or skull. Provide safe control: PLr = d in conjunction with category 3 according to EN ISO 13849-1:2015 and	5.1.13	D, V, T
		1.1.2 Operating/maintenance instructions: The skull growth is unpredictable and therefore inspection should be made to ensure that the skull does not collide with the lance in the preselected tilted position	7.3.5	V

Significant hazard	Hazardous situation	Safety requirements and/or measures	Reference	Verification
5.2.6.5 Maintenance and repair of converter refractory lining				
1 Combination of hazards	1.1 Unexpected movement of converter	1.1.1 Unexpected movement of converter shall be avoided. Provide safe control: PLr = d in conjunction with at least category 3 according to EN ISO 13849-1:2015 and	5.1.13	D, T
		1.1.2 Operating/maintenance instructions	7.3.5	V
	1.2 Movement of converter	1.2.1 Movement of converter shall only be initiated by hold-to-run control and enabling button from local control stand and	5.1.25	D, T
		1.2.2 Operating/maintenance instructions	7.3.5	V
5.2.7 Maintenance (<u>not</u> during process)				
5.2.7.1 Repair				
1 Combination of hazards	1.1 Unexpected movements of equipment in converter area	1.1.1 All energy sources causing a danger shall be isolated and		D, V
		1.1.2 Operating/maintenance instructions	7.3.5	V
	1.2 Fluids and gases	1.2.1 Media like gases and fluids shall be switched off and depressurized, if necessary and		D, V
		1.2.2 Operating/maintenance instructions	7.3.5	V
	1.3 Falling skull	1.3.1 Operating/maintenance instructions: Repair area shall be checked for skulls and all detected skulls shall be removed	7.3.5	V
2 Burns	2.1 Hot surfaces	2.1.1 Operating/maintenance instructions	7.3.5	V
5.2.7.2 Refractory breakout and relining				
1 Combination of hazards	1.1 Refractory breakout	1.1.1 Unexpected movement of converter shall be avoided. Provide safe control: PLr = d in conjunction with at least category 3 according to EN ISO 13849-1:2015 at, e.g. local control stand and	5.1.13	D, T
		1.1.2 Operating/maintenance instructions	7.3.5	V
	1.2 Unexpected movements of equipment in converter area during relining	1.2.1 All energy sources causing a danger shall be isolated and		D, V
		1.2.2 Operating/maintenance instructions	7.3.5	V
	1.3 Fluids and gases	1.3.1 Media like gases and fluids shall be switched off and depressurized with visible and lockable disconnection and		D, V
		1.3.2 Fresh air shall be supplied and		D, V
		1.3.3 Operating/maintenance instructions	7.3.5	V

Significant hazard	Hazardous situation	Safety requirements and/or measures	Reference	Verification
	1.4 Falling skull	1.4.1 Operating/maintenance instructions: Repair area should be checked for skulls and all detected skulls should be removed	7.3.5	V
5.2.7.3 Relining machinery/device				
1 Falling objects	1.1 Falling of objects, e.g. skulls from off-gas duct into the converter	1.1.1 Provide protection, e.g. protection platform and		D, V
		1.1.2 Operating/maintenance instructions: 1) Off-gas duct should be cleaned after cooling; 2) Protection platform or alternative protection measure should be positioned before using the machinery/device	7.3.5	V
	1.2 Falling of objects from relining platform	1.2.1 Safeguarding, e.g. safety net, cover plates	5.1.4	D, V
	1.3 Falling of objects, e.g. skulls from converter mouth on relining platform	1.3.1 Operating/maintenance instructions: Repair area should be checked for skulls and other objects and all detected objects should be removed	7.3.5	V
2 Shearing and crushing	2.1 Unexpected horizontal movements of the relining machinery/device	2.1.1 Prevent unexpected horizontal movements and		D, V
		2.1.2 Provide safe control PLr = c in conjunction with at least category 1 according to EN ISO 13849-1:2015 and	5.1.13	D, T
		2.1.3 Operating/maintenance instructions	7.3.5	V
	2.2 Unexpected vertical movements of parts of the relining machinery/device, e.g. lifting of working platform	2.2.1 Prevent unexpected vertical movements and		D, T
		2.2.2 Provide safe control PLr = d in conjunction with at least category 3 according to EN ISO 13849-1:2015 and	5.1.13	D, T
		2.2.3 Operating/maintenance instructions	7.3.5	V
3 Slip, trip, fall	3.1 Falling from the relining machinery/device, working platform, car for horizontal movement, etc	3.1.1 Provide safeguarding, e.g. railing, anchor points for PPE and		D, V
		3.1.2 Operating/maintenance instructions: PPE	7.3.5	V
	3.2 Instability of the relining machinery/device in elevated position, e.g. during maintenance outside the converter	3.2.1 Design measures, e.g. design center of gravity to avoid instability and		D, V
		3.2.2 Operating/maintenance instructions	7.3.5	V

Significant hazard	Hazardous situation	Safety requirements and/or measures	Reference	Verification
4 Ergonomic hazards	4.1 Incorrect posture during relining work	4.1.1 Operating/maintenance instructions: Position the working platform in ergonomic relation to the refractory lining	7.3.5	V
	4.2 Insufficient lighting	4.2.1 Provide sufficient lighting and	EN 12464	D, V
		4.2.2 Operating/maintenance instructions: personal lighting device should be used NOTE National regulations regarding safety voltage for confined spaces to be followed	7.3.5	V
5 Combination of hazards	5.1 Burns and scalds from hot water and steam, e.g. from off-gas system	5.1.1 Operating/maintenance instructions: e.g. depressurize and cool down the off-gas system	7.3.5	V
	5.2 Equipment collision and/or unintentional material discharge, etc.	5.2.1 Operating/maintenance instructions: tilting drive(s) and all neighbouring equipment, e.g. lance, sub-lance, material handling equipment, transfer cars should be de-energized or alternative measures should be undertaken, etc.	7.3.5	V
	5.3 Evacuation of personnel from lining machinery/device, e.g. in case of			
	— Fire	5.3.1 Operating/maintenance instructions: Avoidance of waste materials (e.g. empty bags) in working area, non-smoking area due to inflammable waste material, welding or similar activities should be avoided, fire extinguishers ready to be used at working places NOTE National regulations regarding safety voltage for confined spaces and fire protection to be followed	7.3.5	V
	— Failure of energy	5.3.2 Provide escape possibilities which could also be used by loss of energy, e.g. ladder		D, V
	Only for converter with fixed bottom, or after bottom fixing for removable bottom converters:			
	5.4 Hazardous gas concentration in the converter vessel	5.4.1 Provide ventilation by fresh air and		D, V, T
		5.4.2 Media like gases and fluids shall be switched off and depressurized with visible and lockable disconnection and		D, V

Significant hazard	Hazardous situation	Safety requirements and/or measures	Reference	Verification
		5.4.3 Operating/maintenance instructions: PPE, work management for working in confined spaces: e.g. detection of breathable atmosphere before first access; wearing personnel gas monitoring devices during relining; use of safety voltage devices NOTE National regulations regarding working in confined spaces to be followed.	7.3.5	V
6 Thermal hazards	6.1 High temperature of — permanent lining of the converter — the steel plates of the converter shell	6.1.1 Operating/maintenance instructions: PPE, cooling down time should be observed	7.3.5	V

6 Verification of the safety requirements and/or measures

It is necessary to verify that the requirements of this standard have been incorporated in the design and manufacture of steel converter.

The verification required is defined in 5.2, Table 1 and includes validation.

Verification/validation of safety-related parts of control systems shall be made according EN ISO 13849-2.

Verification of the declared noise emission values shall be made according to the noise test code given in Annex C.

Verification and validation shall take place during or after completion of commissioning. If partial disassembly is necessary, e.g. to gain access it shall not affect the function being verified. Safety devices put out of operation for verification shall be restored before verification is completed.

An adequate time frame for validation should be considered within the project schedule and agreed upon with the user.

7 Information for use

7.1 General

Instructions shall be provided according to EN ISO 12100:2010, Clause 6.

In addition to these requirements, the instruction handbook shall include the following information:

a) name and address of the manufacturer or where applicable the authorized representative;

b) declaration of series or type;

c) EC declaration of conformity;

d) the noise emission values determined according to Annex C;

e) the vibration total value to which the hand-arm system is subjected, if it exceeds 2,5 m/s^2. Where this value does not exceed 2,5 m/s^2, this shall be mentioned;

f) the highest root mean square value of weighted acceleration to which the whole body is subjected, if it exceeds 0,5 m/s² according to 5.1.23. Where this value does not exceed 0,5 m/s², this shall be mentioned;

g) the uncertainty of measurement.

NOTE 1 Experience has shown that the magnitude of hand-arm vibration of these machines is in general significantly below 2,5 m/s².

NOTE 2 This single whole-body vibration emission value determined under particular operating condition is not representative for the various conditions in accordance with the indented use of the machinery. Consequently, this single whole-body vibration emission value declared by the manufacturer in accordance with this European Standard is not indented to determine the whole-body vibration exposure to the operator of the machinery.

NOTE 3 Information to the uncertainty of vibration measurement and the declaration of verification of vibration values are given in EN 12096.

7.2 Warning devices and safety signs

Warning devices and safety signs shall meet the requirements of 5.1.9 and EN 61310-1 and EN 61310-2.

Appropriate signs shall be in accordance with ISO 7000.

7.3 Accompanying documents

7.3.1 Instruction handbook

The manufacturer shall provide an instruction handbook for each steel converter covering all auxiliary systems incorporated into the steel converter. See also EN ISO 12100:2010, Clause 6 where the essential safety requirements are listed. In this manual, the characteristics and measures to the specific machines shall be designated.

The instruction handbook shall contain the safety layout.

Given below are examples of the structure and content of an instruction handbook, which shall be completed or extended depending on the specific machine/equipment.

7.3.2 Machine/equipment declaration

The machine/equipment declaration shall include:

a) manufacturer, type of machinery/equipment, year of manufacture, serial number/machine number;

b) technical documents (circuit diagrams, data sheets, information/reference for spare parts);

c) for intended use with details on take-over-points of additional/optional machinery/equipment;

d) for non-intended use (e.g. forbidden use of specific auxiliary equipment, prohibition of specific materials);

e) interface description of safety-related auxiliary equipment and their required control (e.g. interlocking, effect of safety devices).

7.3.3 Instruction for transport, setting up/installation

The instruction for transport, setting up/installation shall include:

a) transport dimensions;

b) packing and storage instructions;

c) lifting instructions (e.g. transport rig, ring bolt, center of gravity);

d) transportation weight;

e) transport safety devices and their removal before commissioning;

f) plant layout/installation conditions (e.g. foundation plan, building requirements);

g) reference to installation/assembly of the machinery/equipment or single parts of the machine;

h) instruction regarding overturn protection and falls from high areas;

i) instruction about correct connection of the take-over-points.

7.3.4 Instruction about erection, commissioning and dismantling

The instruction about erection, commissioning and dismantling shall include:

a) provision of energy (electric, hydraulic, pneumatic, etc.);

b) filling amounts;

c) fluids specifications;

d) fitting of special devices;

e) starting, operation and shut-down;

f) inspection of safety devices before commissioning;

g) prohibition of unauthorised reconstruction and modification;

h) reference for dismantling (e.g. instructions for de-pressurizing);

i) reference for disposal (e.g. disposal of high pressure fluids).

7.3.5 Operation instructions concerning the equipment

7.3.5.1 General

The operation instructions concerning the equipment shall include:

a) installed safety devices;

b) regular testing of safety devices;

c) characteristic hazards (e.g. electrical, hydraulic, gases, especially references to relining and start-up after relining) including recommended PPE;

d) processing of materials which generate, e.g. gas, fume or dust hazardous to human health;

e) description of safety related control systems;

f) information about noise emission according to Annex C of this document and, where necessary, recommendation to, e.g.:

   1) implement enclosures, protection shields by the user,

   2) use of cabins for the personnel,

   3) wear hearing protection, and

   4) visual sign posting of noisy areas.

   Noise information should also be provided in the sales literature.

g) information about hand-arm and whole body vibration, if any;

h) information:

   1) about the tilt angle of the converter for different operating positions, e.g. charging position, sampling position, blowing position, preheating position before the respective operation is started,

   2) that the operator should undertake all the relevant precautions to prevent the collision between the blowing lance and the converter also considering skull formation,

   3) that during this procedure the position of the blowing lance where the oxygen valve is opened can be different from the process blowing position,

   4) that care has to be taken that the oxygen is released inside the converter (see 5.2.6.4),

   5) about special instructions for actions to be taken in case of loss of energy (see 5.1.19),

   6) about areas where the risk of artificial optical radiation (e.g. infrared) exists (see 5.1.20),

   7) about special instructions for actions to be taken in case of emergency (see 5.1.21),

   8) about equipment linked to a steel converter, particularly instructions and safety measures including monitoring requirements for the take-over-points (see 5.1.24).

i) operator:

   1) references about the necessary qualification of operators,

   2) instructions for the operator on how to operate the machine/equipment,

   3) prior to commencing work, new staff shall be trained,

   4) for restart, thorough check that no person is in the danger zone, that the access doors are closed and confirmation button (reset push button) (e.g. next to door) is pressed.

j) introduction to safety devices and procedure to follow in case of an accident;

k) action (trouble shooting) in the event of faults or irregularities and abnormal conditions;

l) references to residual risks due to hazards from, e.g.:

1) gases,

2) heat radiation,

3) hot surfaces in the working area,

4) ejection of material or product parts,

5) non-relieved pressures,

6) temperature,

7) fire,

8) oversized scrap,

9) water, ice, moisture in scrap, flux or allow material.

m) references to particular hazards in case of access to the machine on special occasions (e.g. maintenance, trouble-shooting) shall be pointed out in the instruction handbook referring to the nature of the hazard (see EN 61310-1). If the protective devices are not available during this action the applicable measures shall be described.

7.3.5.2 Specific instructions in the operating manual

For the following exemplary hazardous situations (see Table 2) proposals for references to the user are given which can be used in addition to those of Table 1.

Table 2 — Exemplary hazardous situations and proposals for references to the user

Hazardous situation	**Reference to the user (examples)**
General:	
— poisoning by CO	Access to hazardous converter areas (shown in the safety layout) by authorized personnel only: — Organizational measures to be undertaken by the user — …
— warning devices	— All devices shall be regularly inspected for proper function and — In case of failure replacement or — temporary alternative organisational measures shall be introduced till the failure has been rectified — …
— safety devices/equipment	— All devices/equipment shall be regularly inspected for proper function — …
Ground floor:	
— cleaning underneath the converter: steel splashing, leakage or ejection caused by breakthrough or reaction during blowing, charging and tapping process	Access to the hazardous area at ground floor shall only be permitted by authorized personnel having overview over the danger zone from converter control room, when: — the converter is not in operation and

Hazardous situation	**Reference to the user (examples)**
	— converter in upright position and — tilting is forbidden (organisational measure) and — cleaning allowed by a special protected vehicle only — …
Converter platform:	
— substantial water leakage of blowing lance or sub-lance into liquid steel: physical explosion accompanied with danger of steel splashing	After the blowing has been interrupted by the control system access to the hazardous area at converter platform shall only be permitted by authorized personnel having overview over the danger zone from converter control room: — the converter should not be tilted unless it is decided by trained personnel that all the water inside the vessel has evaporated and — inspect the lance and change in case of visible damage and — reduce the bottom stirring flow rate to a minimum and — the process should be resumed only after thorough inspection of the entire system by trained personnel — ….

7.3.6 Maintenance instructions

The maintenance instructions shall contain at least:

a) tests to be carried out;

b) maintenance work;

c) repair work;

d) protective measures against hazardous situations, e.g. temporary safeguarding;

e) advice for those maintenance activities that require special knowledge or qualification;

f) lists of spare parts with reference to drawings or circuit diagrams;

g) periodical inspection programme of the safety devices;

h) frequency of these inspections shall be defined at the design stage according to the reliability, nature and importance of the device;

i) particularly the following instructions shall be considered in the maintenance instructions:

   1) instructions on preventive measures (e.g. replacement of wear parts, lubrication, etc.);

   2) instructions on error messages of the control system and the actions resulting from this;

   3) fault lists indicating causes of trouble and measures to be taken;

   4) instructions as to which parts of the system(s) shall be switched off during repair work;

5) where necessary, instructions on existing residual energy (hydraulic tank, etc.) and its reduction.

7.4 Minimum marking

The following information shall be attached clearly, readably and durably (e.g. at the converter control room):

a) name and address of manufacturer and where applicable the name and address of the authorized representative;

b) designation of the machinery;

c) mandatory marking[1)];

d) serial number/machine number;

e) month and year in which the manufacturing process is completed.

7.5 Training of personnel

The Instruction for use shall contain a reference that supervisors and personnel shall receive training in all safety aspects prior to the commissioning of the plant.

This training shall consider the entire life of the equipment, and shall specifically cover the following operating conditions:

a) plant start-up;

b) normal operation;

c) operation under fault conditions;

d) emergency procedures to be applied;

e) service and maintenance.

1) For machines and their related products intended to be put on the market in EEA, CE marking shall be applied as defined in the European applicable directive(s), e.g. Machinery, Low Voltage, Explosive Atmosphere, Gas appliances.

Annex A
(normative)

Safety requirements for electrical equipment and for safety related control systems

A.1 General

General and specific requirements and additional measures for electrical equipment, safety related control systems and shut down equipment to be selected are described below. Manufacturer shall identify through an individual risk assessment (see EN ISO 12100:2010, Clause 4) which hazards are relevant for the electrical equipment (see EN 60204-1:2006, Clause 4) and safety related control systems (see EN ISO 13849-1). The special conditions for complex installations shall to be taken into account by the manufacturer.

The IP class according to EN 60529 of any electrical equipment to be used as per environmental conditions. For details, see EN 60204-1:2006, 10.1.3 and 11.3.

The IP-code classification only takes into account the ingress of water/dust and not of other fluids; for those fluids specific precautions should be made.

The special conditions for complex installations are to be taken into account by the manufacturer.

A.2 Special requirements for safety related control systems

When designing the control system the cycle time of the programmable logic control (PLC) system shall be taken into account because it takes some time for the PLC to scan input, process data and set output. Depending on where the PLC “looks” at the time of the signal input the delay caused by the PLC will randomly vary from approximately 5 msec to 100 msec. Often such a variation can cause additional hazards. It is advisable to use an interrupt function to get constant quick response from the PLC for functions that can cause hazards, e.g. by hold-to-run control.

Safety related control systems shall at least be designed corresponding to required performance level PLr = c in conjunction with at least category 1 according to EN ISO 13849-1:2015.

A.3 Special requirements for shut-down equipment

A.3.1 Stop functions and emergency stop functions

In conformity with the requirements of EN ISO 12100:2010, 6.2.11.3, EN ISO 13850 and EN 60204-1 as well as EN 1037, the stop and emergency stop functions in A.3.2 shall be applied.

Furthermore, the following shall be applicable to normal stop and emergency stop functions:

a) In inter-linked plants, it shall be ensured that the upstream and/or downstream equipment is shut down. Where stored energies are a source of danger they shall be eliminated, isolated or reduced to a level which does not cause a risk. Where required, power shall remain available and controlled for certain purposes:

   1) to preserve the integrity of facilities provided for rescuing stranded personnel from the danger zone according to EN ISO 13850:2015, 4.1.1.2;

2) to preserve the effectiveness of safety devices or equipment with a safety-related function according to EN ISO 13850:2015, 4.1.1.3; and

b) to carry out mechanical movements of machine for releasing trapped personnel or rescuing injured persons.

Emergency stop devices shall meet the requirements of EN 60204-1 and EN ISO 13850.

A.3.2 Emergency stop

Emergency stop devices shall be:

a) easily identifiable in accordance with the requirements of EN ISO 13850;

b) located at every control desk as well as other locations where the activation according to the risk assessment is required, according to EN 60204-1;

c) marked to indicate the subarea of the plant affected by their operation;

d) readily accessible as defined in EN ISO 13850.

When an emergency stop device has been operated, a re-start shall only be possible from a safe position outside the danger zone with a clear view of the danger zone.

A.3.3 Emergency stop assigned to areas

When designing a steel converter, it shall be determined according to a risk assessment how the steel converter shall be subdivided into individual "emergency-stop areas". The decisions made will be dependent on what parts of the steel converter machinery can be operated separately and what risks can arise from shutting down independent parts of the steel converter when other parts are left running.

The steel converters and their complexity make special demands necessary, e.g. on protective measures during partial shutdown and restarting. Therefore, time-delayed visible and audible warning devices (EN ISO 7731, EN 842) shall be provided for the re-start.

A.3.4 Emergency stop functions

On the basis of the risk assessment the manufacturer shall select the emergency stop functions according to EN 60204-1. The PLr of the emergency stop function shall conform to the PLr of the respective movement.

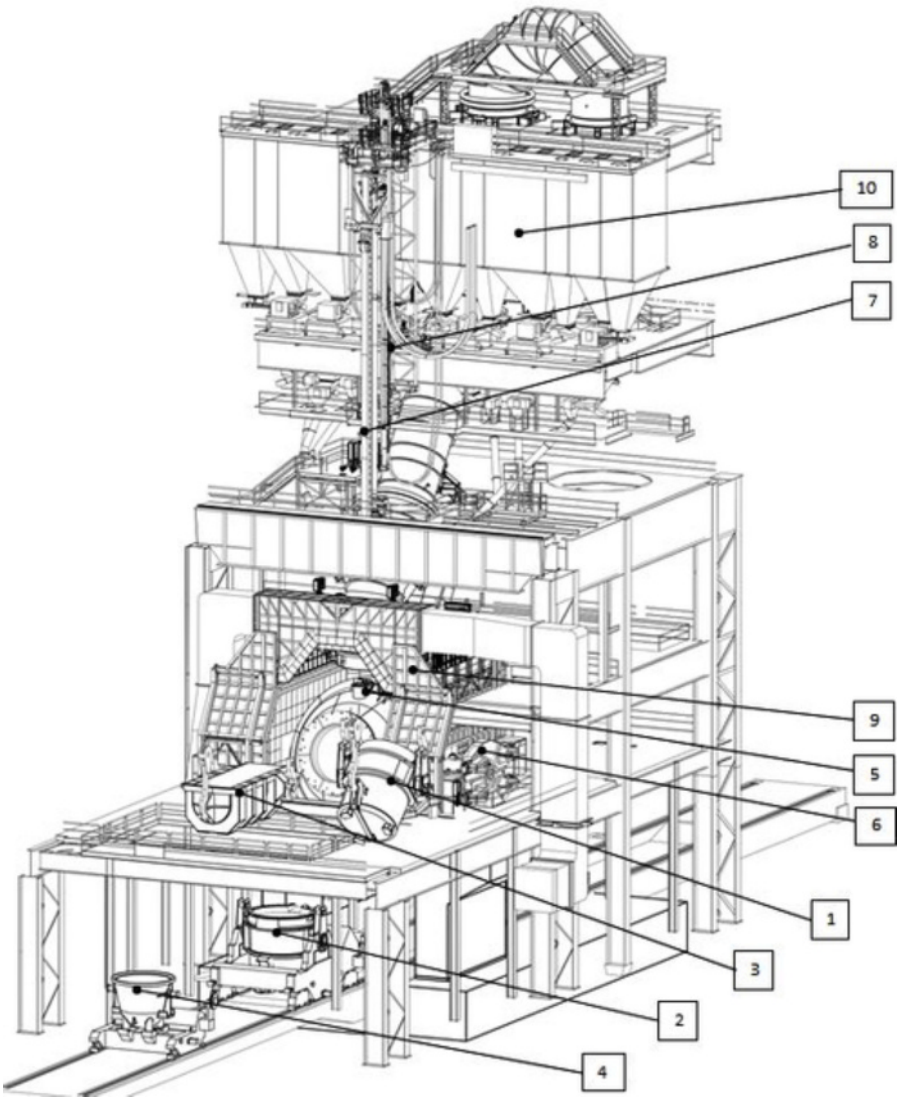
A.3.5 Emergency off

An emergency off function according to EN 60204-1:2006, 9.2.5.4.3 (i.e. in terms of a plant-related emergency off) is not applicable for steel converters, because higher risks can occur due to plant complexity.

Annex B
(normative)

Steel converter and its associated equipment for the oxygen steelmaking process

An example of a steel converter and its associated equipment for the oxygen steelmaking process is illustrated hereafter.



Key

1	hot metal ladle	6	tilting drive
2	teeming ladle	7	oxygen blowing lance
3	scrap chute	8	sub-lance
4	slag pot	9	doghouse
5	converter vessel	10	material handling system

Figure B.1 — Exemplary illustration of a steel converter and its associated equipment for the oxygen steelmaking process

Annex C
(normative)

Noise test code

C.1 Introduction

Steel converters are not standard machines and are tailored to customers' specifications.

The noise emission of a steel converter depends on many parameters, in particular:

a) converter type (e.g. AOD, BOF) and size;

b) process steps, e.g.:

   1) scrap charging,

   2) material feeding,

   3) blowing,

   4) tapping, e.g. slag stopper,

   5) ladle alloying,

   6) slag splashing;

c) skull removal per lance.

These parameters cannot be standardised as they differ from one steel converter to another.

In order to make tests repeatable, the precise operation procedures of the steel converter have to be known. This is why this noise test code requires these procedures to be recorded, reported and declared in detail.

Steel converters never operate at the manufacturers place. Noise emission measurement can only be carried out after commissioning.

This noise test code specifies all the information necessary to carry out efficiently and under standardised conditions the determination, declaration and verification of noise emission characteristics for steel converter.

The noise emission of a machine in general is described by two quantities that are used by the manufacturer to declare the noise emitted:

— the A-weighted emission sound pressure level at work stations, and

— the A-weighted sound power level.

However, due to the size and complexity of a steel converter, the noise emission of a steel converter is described by the A-weighted emission sound pressure level at work stations and specified measuring points. The determination of these quantities is necessary for:

— manufacturers to declare the noise emitted;

— purposes of noise control at the source at the design stage.

NOTE Emission sound pressure levels in frequency bands may also be determined.

C.2 Determination of sound power level

There would be a need to determine the sound power level of a steel converter because the A-weighted emission sound pressure level at some work stations is higher than 80 dB. However, limited access for safety reasons in the vicinity of a steel converter in operation and high heat radiation make it impossible to determine the sound power level. Instead and because steel converter are very large machines, A-weighted emission sound pressure levels at specified measuring points (see Figure C.1) shall be determined in accordance with the method specified in C.3.1.

C.3 Determination of emission sound pressure levels

C.3.1 Determination of the emission sound pressure level at specified measuring points

Relevant measuring points shall be specified at converter platform and lance cleaning platform only (see Figure C.1) because the presence of personnel in other areas during production process is not necessary. The measurement shall be carried out at a height of 1,6 m.

The measurement positions shall be recorded and reported (see C.6).

The A-weighted emission sound pressure level shall be determined in accordance with EN ISO 11202. Due to the fact, that there is one dominant noise source (blowing process) and depending on the value of the local environment correction K3, grade 2 or grade 3 results can be used.

NOTE In general, measurement at 1,6 m height and regularly spaced around the converter or lance cleaning platform is not possible due to the general design of a converter.

C.3.2 Determination of emission sound pressure level at operating stations

The A-weighted emission sound pressure level shall be determined at permanent or temporary operating stations (see 3.13.1).

The position of the work stations shall be recorded and reported.

The A-weighted emission sound pressure level shall be determined in accordance with EN ISO 11202. Due to the fact, that there is one dominant noise source (blowing process) and depending on the value of the local environment correction K3, grade 2 or grade 3 results can be used.

C.4 Measurement uncertainties

The total measurement uncertainty of the noise emission values determined according to this standard is depending on the standard deviation of reproducibility of the measurement:

σ_{R0}

as given by EN ISO 11202:2010 and the uncertainty associated with the instability of the operating and mounting conditions:

$\sigma\ omc$

The resulting total standard deviation $\sigma\ tot$ is then calculated as:

$$\sigma\ tot^2 = \sigma_{R0}^2 + \sigma\ omc^2$$

The upper bound value of σ_{R0} is about 1,5 dB for the grade 2 measurement methods dealing with the determination of the emission sound pressure level or the sound power level.

NOTE 1 For more information on measurement uncertainty, see EN ISO 11202:2010, Clause 12 and Annex C.

NOTE 2 For machines with a rather constant noise emission, a value of 0,5 dB for σ *omc* can apply. In general, converters have an instable noise emission, especially during the blowing process (e.g. different blowing conditions and different input materials). In this case, a value of 2 dB may be more appropriate. Methods to determine σ *omc* are described in EN ISO 11202:2010, Annex C.

The expanded measurement uncertainty U, in decibels, shall be calculated with k = 2, the coverage factor, for two-sided normal distribution at confidence level of 95 %, from:

$$U = k \sigma tot$$

NOTE 3 The expanded measurement uncertainty depends on the desired confidence level. For the purpose of comparing the result with a limit value, it is appropriate to apply the coverage factor for a one-sided normal distribution. In that case, the coverage factor k = 1,6 corresponds to a 95 % confidence level. Further information is given in ISO 4871. Note that the expanded measurement uncertainty U is denoted K in ISO 4871.

C.5 Operating conditions

In general, the noise emission measurements shall be made during a complete process cycle from tap-to-tap.

If applicable, measurement at work stations shall be carried out for the part of the process cycle where presence of persons is required.

Because there is a large influence of different blowing conditions and different input materials on noise emission, it is necessary to record, report and declare the process data so that the declared noise emission values are fully traceable to operating conditions and can be verified.

C.6 Information to be recorded and reported

The information recorded when carrying out the noise measurement and the measurement report shall at least contain the following information:

a) manufacturer, kind of machine/plant, boundary and technical data and sizes;

b) operating conditions and parameters under which noise is measured (see C.5);

c) measurement results:

   1) A-weighted emission sound pressure level at each operating station (accompanied by a drawing showing the position of each operating station on the steel converter);

   2) A-weighted emission sound pressure level at each specified measuring point (accompanied by a drawing showing these points on the steel converter);

   3) possible deviations to this noise test code or to EN ISO 11202, with the justification for them;

d) precise position of operating stations, specified measurement points and duration of measurement;

e) place and date of measurement identifying information of the responsible person/body.

C.7 Declaration and verification of noise emission values

For steel converter only typical values can be given as noise emission values before commissioning. The noise emission shall then be measured under the specific production conditions and declared after commissioning.

The following noise emission values shall be declared:

a) A-weighted emission sound pressure level at each operating station (accompanied by a drawing showing the position of each operating station on the steel converter);

b) A-weighted emission sound pressure level at each specified measuring point (accompanied by a drawing showing these points on the steel converter).

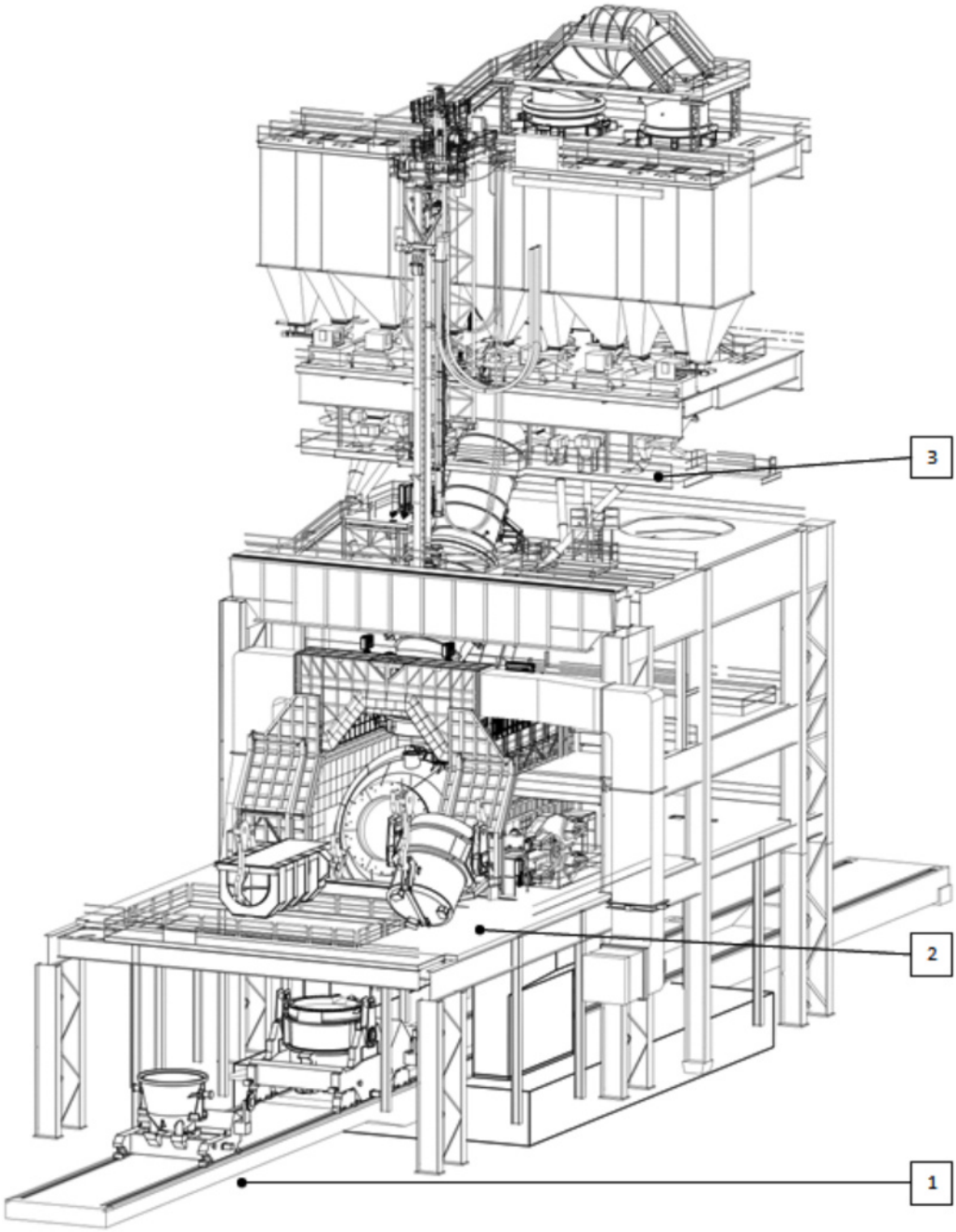
The noise declaration shall give detailed information on the operating conditions and parameters of the steel converter during noise measurement and at least those indicated in C.5.

The declaration shall be made as dual-number noise emission values (measured value and associated uncertainty given separately). The noise declaration shall be made in such a way that the values can be verified according to EN ISO 4871:2009, 6.2.

The noise declaration shall explicitly mention the fact that the noise emission values have been obtained according to the specifications of this noise test code and make reference to EN ISO 11202. If this statement does not apply, the noise declaration shall indicate clearly what the deviations are from these specifications and/or from the basic standard.

In case of verification of the declared noise emission values this shall be done using this noise test code and under the same operating conditions used for declaration.

Table C.1 shows an example of a dual-number noise declaration.



Key

1 ground floor (not relevant for noise measurement, for illustration only)
2 converter platform (local control stand(s) for tapping, de-slagging and charging)
3 lance cleaning platform (temporary workplace(s) for lance cleaning)

Figure C.1 — Exemplary illustration of a BOF converter platform and lance cleaning platform

Table C.1 — Example of declared dual-number noise emission values for operating stations and specified points

Plant name	
Converter type / number	
Date of readings	
Reference to heat report[1)]	

[1)] The heat report contains all relevant data to document the process

DECLARED DUAL-NUMBER NOISE EMISSION VALUES

Declared A-weighted emission sound pressure level at operating stations and specified points A to ...				
Operating stations and specified points		**Measured value** L_{pA} [dB] (re 20 µPa)	**Uncertainty** K_{pA} [dB]	**Reference point** X, Y [m]
A	During the whole process: Converter control room			
B	During charging: Local control stand charging			
C	During de-slagging: Local control stand de-slagging			
D	During tapping: Local control stand tapping			
E	During the whole process: Converter platform (measurement point(s) to be specified)			
F	During lance cleaning: Lance cleaning platform (measurement point(s) to be specified)			
G	...			
Values determined according to noise test code of EN 16774:2016, Annex C and measurement standard EN ISO 11202.				

NOTE The sum of a measured noise emission value and its associated uncertainty represents an upper bound of the range of values which can occur in measurements.

Annex ZA
(informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 2006/42/EC (Machinery Directive) aimed to be covered

This European Standard has been prepared under a mandate to provide one voluntary means of conforming to essential requirements of the New Approach Directive 2006/42/EC on machinery

Once this standard is cited in the Official Journal of the European Union under that Directive, compliance with the normative clauses of this standard confers, within the limits of the scope of this standard, a presumption of conformity with the with the corresponding essential requirements of that Directive and associated EFTA regulations.

WARNING 1 — Presumption of conformity stays valid only as long as a reference to this European Standard is maintained in the list published in the Official Journal of the European Union. Users of this standard should consult frequently the latest list published in the Official Journal of the European Union.

WARNING 2 — Other Union legislation may be applicable to the product(s) falling within the scope of this standard.

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[2] EN ISO 11688-2, *Acoustics — Recommended practice for the design of low-noise machinery and equipment — Part 2: Introduction to the physics of low-noise design (ISO/TR 11688-2)*

[3] EN ISO 11691, *Acoustics — Measurement of insertion loss of ducted silencers without flow — Laboratory survey method (ISO 11691)*

[4] EN ISO 11820, *Acoustics — Measurements on silencers in situ (ISO 11820)*

[5] EN ISO 11821, *Acoustics —Measurement of the in situ sound attenuation of a removable screen (ISO 11821)*

[6] EN 61511-1, *Functional safety — Safety instrumented systems for the process industry sector — Part 1: Framework, definitions, system, hardware and software requirements (IEC 61511-1)*

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