



BSI Standards Publication

Safety of machinery — Safety requirements for hot flat rolling mills

National foreword

This British Standard is the UK implementation of EN 15093:2022. It supersedes BS EN 15093:2008, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee MCE/23, Safety of metal producing mills.

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

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English Version

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Sécurité des machines - Prescriptions de sécurité
relatives aux laminoirs à chaud pour produits plats

Sicherheit von Maschinen - Sicherheitsanforderungen
an Warmflachwalzwerke

This European Standard was approved by CEN on 26 December 2021.

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European foreword

This document (EN 15093:2022) has been prepared by Technical Committee CEN/TC 322 “Equipment 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of an identical text or by endorsement, at the latest by September 2022, and conflicting national standards shall be withdrawn at the latest by September 2022.

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

This document supersedes EN 15093:2008.

Any feedback and questions on this document should be directed to the users’ national standards body. A complete listing of these bodies can be found on the CEN website.

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

Introduction

This document is a type C standard as stated in EN ISO 12100:2010.

This document is not applicable to hot rolling mills for flat products manufactured before the date of its publication.

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

- machine and/or plant 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 and/or plant users/employers (small, medium and large enterprises);
- service providers, e.g. for maintenance (small, medium and large enterprises).

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

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

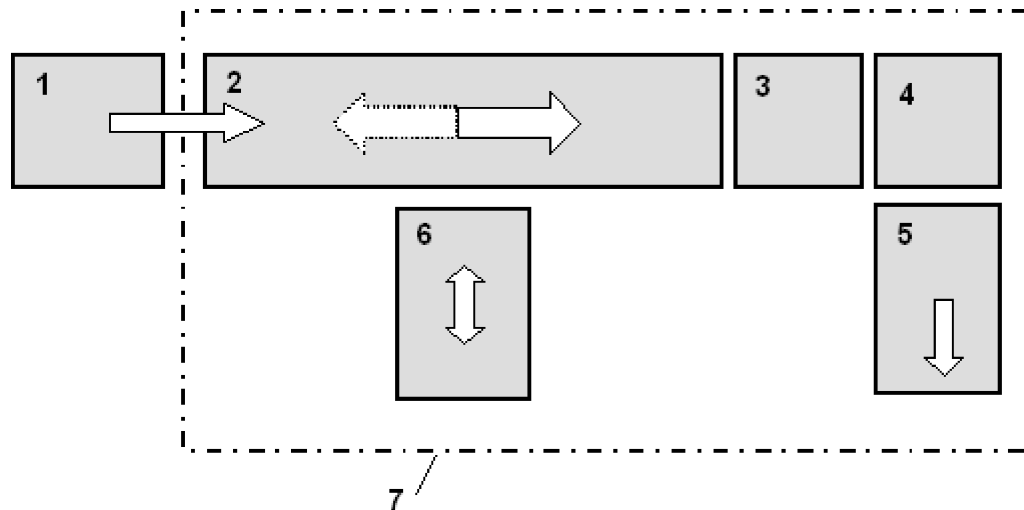
Where for clarity an example of a preventative measure is given, this should not be considered as the only possible solution. Any other solution leading to the same risk reduction is permissible if an equivalent level of safety is achieved.

When requirements of this type-C standard are different from those which are stated in type-A or -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 document specifies the general safety requirements for hot rolling mills for flat products as defined in 3.1.

This document is applicable to: Plant (machinery, equipment, devices according Annex D) used for the manufacturing of metal hot rolled flat products from the from entry (1), via the mill stands (2) with roll changing devices (6), to the exit (5) (see Figure 1).



Key

- | | | | |
|---|---|---|--------------------------------------|
| 1 | material supply (excluded from the Scope),
e.g. continuous casting machine (according to EN 14753) or
furnace (according to EN 746-1) | 4 | coiler or plate transport |
| 2 | mill stands, including e.g. descaling unit, roller tables | 5 | material removal or plate processing |
| 3 | cooling line | 6 | roll changing devices |
| | | 7 | border of the hot rolling mill |

Figure 1 — Exemplary layout of a hot flat rolling mill

This standard does not cover:

- thermo process equipment, e.g. in accordance with the EN 746 series; including furnaces of a steckel mill;
- continuous casting machines according to EN 14753;
- hook conveyors according to EN 619;
- non-fixed load lifting attachments, e.g. according to EN 13155;
- roll shop equipment;
- storage equipment (e.g. high-bay warehouses);
- cranes, fork lifts, trucks and railway trucks and other vehicles;
- process technology (e.g. treatment of water, rolling lubricant, compressed air, etc.);

- separate cleaning system for exhaust air;
- firefighting system;

NOTE 1 Please refer to Annex C for information regarding the special requirements for protection of persons in case of using asphyxiant gases used in firefighting system.

- the design of the building, halls and civil works.

This document deals with significant hazards, hazardous situations or hazardous events relevant to hot rolling mills for flat products, when it is used as intended and under conditions of misuse which are reasonably foreseeable by the manufacturer. It provides the requirements to be met by the manufacturer to ensure the safety of persons and property during transport, commissioning, operation and de-commissioning, as well as in the event of foreseeable failures or malfunctions that can occur in the equipment.

NOTE 2 For modernization, this document (C-type standard) can be applied for the part to be modernized.

This document is not applicable to hot rolling mills for flat products manufactured before the date of its publication.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 614-1:2006+A1:2009, *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 894-1, *Safety of machinery — Ergonomics requirements for the design of displays and control actuators — Part 1: General principles for human interactions with displays and control actuators*

EN 894-2, *Safety of machinery — Ergonomics requirements for the design of displays and control actuators — Part 2: Displays*

EN 894-3, *Safety of machinery — Ergonomics requirements for the design of displays and control actuators — Part 3: Control actuators*

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

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

EN 12198-3, *Safety of machinery — Assessment and reduction of risks arising from radiation emitted by machinery — Part 3: Reduction of radiation by attenuation or screening*

EN 12254, *Screens for laser working places - Safety requirements and testing*

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 60204-1:2006, *Safety of machinery - Electrical equipment of machines - Part 1: General requirements*

EN 60825-1, *Safety of laser products - Part 1: Equipment classification and requirements*

EN 60825-4, *Safety of laser products - Part 4: Laser guards*

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

EN 61496-1, *Safety of machinery - Electro-sensitive protective equipment - Part 1: General requirements and tests*

EN 62598, *Nuclear instrumentation - Constructional requirements and classification of radiometric gauges*

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

EN ISO 13854, *Safety of machinery - Minimum gaps to avoid crushing of parts of the human body (ISO 13854)*

EN ISO 13855, *Safety of machinery - Positioning of safeguards with respect to the approach speeds of parts of the human body (ISO 13855)*

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

EN ISO 14118:2018, *Safety of machinery - Prevention of unexpected start-up (ISO 14118:2017)*

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 (all parts), *Safety of machinery - Permanent means of access to machinery (ISO 14122)*

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)*

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

EN 13480-1, *Metallic industrial piping - Part 1: General*

EN 13480-2, *Metallic industrial piping - Part 2: Materials*

EN 13480-3, *Metallic industrial piping - Part 3: Design and calculation*

EN 13480-4, *Metallic industrial piping - Part 4: Fabrication and installation*

EN 13480-5, *Metallic industrial piping - Part 5: Inspection and testing*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN ISO 12100:2010 and the following apply.

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

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

3.1

hot rolling mills for flat products

interconnected equipment for hot rolling of flat material in which several components of the machinery or forming stages are linked by dedicated transport facilities, including associated devices

Note 1 to entry: Plant and equipment which are covered by this document are listed in Annex D.

3.2

safety layout

graphic overview of the hot rolling mill with arrangement of safety-related elements

3.3

hazard zone

danger zone

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

[SOURCE: EN ISO 12100:2010, 3.11]

3.4

take-over-point(s)

point(s) where the hot flat rolling mill is connected to incoming/outgoing material (e.g. coils), media, electricity (e.g. power supply and communication like input/output parameters)

Note 1 to entry: For example, coil take-over-point: Point where overhead cranes or other transport systems deposit or remove coils.

3.5

main route(s)

marked traffic route

3.6

safeguard(ing)

guard or protective device

[SOURCE: EN ISO 12100:2010, 3.26]

3.7

reel (sleeve)

cylindrical hollow body used for coiling the material

3.8

trained person(nel)

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

3.9

authorized person(nel)

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

Note 1 to entry: In contrast, an unauthorized person does not have the required qualification and is not adequately equipped, e.g. PPE.

3.10

maintenance

combination of service, inspection, repair and functional test of the equipment

Note 1 to entry: The purpose is to preserve the working condition or returning to this condition so that the hot flat rolling mill is able to perform the required function (including safety requirements).

3.10.1

service

measure to maintain the nominal condition

Note 1 to entry: The nominal condition can be maintained in general without dismantling/disassembling major parts of the equipment, e.g. by cleaning and lubrication of the work equipment as well as addition or replacement of agents or by replacing tools or operational changing parts (e.g. rolls, knives).

3.10.2

inspection

measure to observe and assess the current condition as well as fault finding

Note 1 to entry: Measures, e.g. measuring, testing, diagnostics including the determination of the causes of wear or damage and the derivation of the necessary consequences for the continued use.

Note 2 to entry: 3.10.2 does not cover “material inspection”, see 3.17.

3.10.3

reconditioning

foreseeable measure to return to the nominal condition requiring dismantling/disassembling

Note 1 to entry: Measure to replace worn parts, damaged parts, or parts having expired the foreseen lifetime (could require dismantling/disassembling). These parts should meet manufacturers' specifications.

3.10.4

functional test

checking of the functionality of the exchanged or repaired parts

Note 1 to entry: It is maybe required to carry out adjustment work, e.g. test runs, verifying safety functions.

3.11

repair

not foreseeable measure(s) to return to the nominal condition

Note 1 to entry: Measure to replace damaged parts, requires in general dismantling/disassembling. These parts should meet manufacturers' specification.

3.12

material

metal being hot-rolled

3.13

coil

coiled material

3.14

strip

flat material

3.15

material supply

devices feeding material to the hot rolling mill and which are linked by control with the hot rolling mill

3.16

material removal

devices removing material from the hot rolling mill and which are linked by control with the hot rolling mill

3.17

material inspection

observe and assess the current condition of the material

3.18

cobbling

material leaving its intended path

3.19

pulpit

enclosed room in which the control desk and monitoring facilities for a machine or equipment are located, used as a permanent workstation

3.20

control stand

free standing control desk (usually situated adjacent to the machine or equipment), used as a temporary workstation

3.21

portable control device

control device which can be used in different places (e.g. control pendant, enabling button, radio control)

3.22

enabling (control) device

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

[SOURCE: EN ISO 12100:2010, 3.28.2]

3.23

hold-to-run control device

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

[SOURCE: EN ISO 12100:2010, 3.28.3]

3.24

control mode(s)

single machines or groups of interlinked machines of hot flat rolling mills can be operated by different control modes

Note 1 to entry: This standard distinguishes between control mode and operating mode. It shall be stated that the meaning is not in line with EN ISO 12100 and EN 60204-1. The operating mode (see 3.25) corresponds to the “control mode” of EN ISO 12100:2010, 6.2.11.9.

3.24.1

manual control mode(s)

3.24.1.1

hold-to-run control

every function is controlled by an operator by means of a button or equivalent device according to 3.28.3 of EN ISO 12100:2010

Note 1 to entry: Release of the button/device stops the function (e.g. movement) immediately.

3.24.1.2

single function

functions are started and/or stopped by an operator

3.24.2

semi-automatic control

sequence of functions released once by an operator

Note 1 to entry: The released sequence is automatically stopped at its end. For the initiation of another sequence, a new command by the operator is required.

3.24.3

automatic control

cycles of successive or parallel sequences once initiated by the operator

Note 1 to entry: If there is no operator intervention, the repetition of the sequences takes place as long as the running conditions are met.

3.25

operating mode(s)

state of the control system allowing to operate the hot flat rolling mill under defined conditions

Note 1 to entry: Such modes are, e.g. production, safe stop, enabling, adjustment, inspection.

Note 2 to entry: The safety level of the operating mode(s) is defined as result of the risk assessment.

3.25.1

special modes

3.25.1.1

enabling mode

operation of machine functions by using an enabling device (as per 3.23)

3.25.1.2

inching (jog) mode

operation of machine functions using a hold-to-run control device (as per 3.24)

3.25.2**safe stop mode**

movement of the involved equipment is prevented through the control system

Note 1 to entry: The required safety level of the safe intervention stop is defined as result of the risk assessment.

Note 2 to entry: Safe intervention stop is not sufficient as a safety measure to perform repair work because isolation of the equipment from the relevant energy sources is not realized.

Note 3 to entry: Residual risks, e.g. by stored energy must have been secured by other means.

Note 4 to entry: Safe stop mode may also include switching off additional devices, e.g. X-ray.

3.25.3**normal production mode**

machine is ready to produce or producing as intended

Note 1 to entry: Production, material handling and activities supporting these processes are covered.

Note 2 to entry: Maintenance according to 3.10 is not covered.

3.26**reduced speed**

speed, reduced to minimize the hazardous potential without safety monitoring of speed

Note 1 to entry: In case of failure, an increase in speed may occur.

Note 2 to entry: Applies to linear or rotational speed.

Note 3 to entry: Speed reduced without an enabling device means that the movement is so slow that the operator can move away from this dangerous movement in time. Based on a risk assessment, an enabling device may therefore be required in some cases, even at a reduced speed (e.g. in narrow spaces).

Note 4 to entry: Examples of reduced speeds include speeds of less than 10 mm/s for presses, less than 250 mm/s for robots, less than 250 mm/s for all non-shearing movements and less than 33 mm/s for shearing or crushing movements.

3.27**safely-limited speed, SLS**

exceeding of a predefined speed limit is safety-related prevented according to EN 61800-5-2:2017, 4.2.3.4

Note 1 to entry: Linear or rotational speed.

3.28

unexpected (unintended) start-up

any start-up caused by:

- a start command which is the result of a failure in, or an external influence on the control system;
- a start command generated by inopportune action on a start control or other parts of the machine, as e.g. a sensor or a power control element;
- restoration of the power supply after an interruption;
- external/internal influences (gravity, wind, self-ignition in internal combustion engines...) on parts of the machine

Note 1 to entry: Automatic machine start-up during normal operation is not unintended but can be considered to be unexpected from the point of view of the operator. Prevention of accidents in this case involves the use of safeguarding.

Note 2 to entry: Definition adapted from EN ISO 14118:2018, 3.2.

3.29

remote access

access from remote location via interface to control systems of the cold flat rolling mill, e.g. for software update

3.30

safety access

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

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

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

3.31

ionizing radiation

x-ray radiation or radiation emanating from radioactive sources

4 Significant hazards and risk assessment

4.1 General

Machinery shall comply with the safety requirements and/or protective/risk reduction measures of Clause 5. In addition, the machine shall be designed according to the principles of EN ISO 12100:2010 for relevant but not significant hazards which are not dealt with by this document.

In general, risks and associated hazards are production and plant related. The main differences arise from the processing of different materials in different qualities and the surroundings (i.e. different combinations of machines, different boundary conditions, see Annex F). The resulting variety of “different plants” could not be covered in all details in a standard. To deal with this fact, an individual risk assessment of the rolling mill in question shall be carried out considering the safety requirements of this document.

If combinations of machines and/or machine functions described at different parts of the standard are located in the same danger zone, the different measures shall be considered together.

4.2 Interfaces to the linked/integrated equipment

The individual risk assessment shall include the interfaces to the linked/integrated equipment, e.g. exhausting systems, radiation emitting system, energy supply (e.g. hydraulic fluids, compressed air, gases, steam), auxiliary equipment and systems.

5 Safety requirements and/or protective/risk reduction measures

5.1 General

Life phases of rolling mills are the following:

- a) manufacture:
 - at the manufacturer's premises: design, manufacture, pre-assembly, transport;
 - transport to facility installation site;
 - on site: assembly, commissioning (in acc. with EN ISO 12100), trial runs;
 - putting into service (first use for its intended purpose, CE marking issued);
- b) operation by plant operator;
- c) disabling and disassembly:

Usually, a rolling mill has a service life of several decades. In the course of the years, rolling mills are repeatedly modernized and adapted to changed technical requirements. Thus, the condition of a rolling mill at the date of disabling is not known. Refer to 7.4.3.

- d) disposal:

Usually, a rolling mill has a service life of several decades. At the time of commissioning, the laws and regulations valid at the date of disposal are not known. Refer to 7.4.3.

See Figure 2.

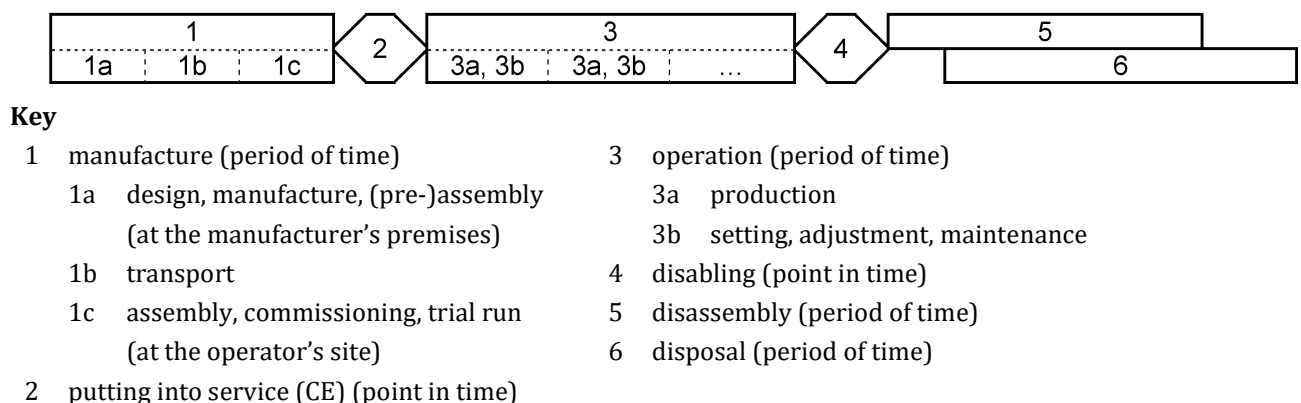


Figure 2 — Schematic representation of the life phases of a hot flat rolling mill

5.2 General requirements for design, planning and risk assessment

5.2.1 General

Rolling mills conforming to this document shall comply with the safety requirements and/or protective/risk reduction measures set out in Clauses 4 and 5 together with those set out in Annexes A, B and C. The information for use shall be according to Clause 7.

The manufacturer shall include in the information for use all details required for a safe operating procedure for the defined operating modes/line conditions. Points for energy isolation and dissipation shall be described in accordance with EN ISO 14118.

It is assumed that rolling mills are operated and maintained by trained personnel (see 3.8).

It is assumed that machinery is used with adequate workplace lighting conforming to EN 12464-1 or to local regulations.

Where frequent access is planned by the manufacturer, permanent means of access shall be provided. Means of access, such as stairways, walkways, platforms, etc. shall be in accordance with EN ISO 14122 (all parts).

It is not required to provide permanent means of access to every part of the machine where temporary activities may be necessary, e.g. for exceptional repair. The manufacturer shall provide in the Information for use instructions about temporary means of access to be used for exceptional access.

Safety devices shall be protected against damage. In particular, they shall be robust to withstand damages related to normal operation in the respective area, e.g. caused by thermal radiation, vibrations, water condensation, dust.

Surfaces for walking or standing shall be selected so that the risks of slips, trips and falls caused by scale, oil, emulsion and/or lubricant are avoided or minimized. Where required, they shall be protected against heat radiation and designed to withstand moving material, tools and jets of high-pressure fluids or gases.

5.2.2 Planning of rolling mills

Even if the manufacturer is not responsible for the planning of the entire plant (e.g. halls, civil works) he shall take into account the following aspects, based on information from the user, in order to ensure good placement and safe operation:

- a) accessibility;
- b) possibility of escape from the rolling mill;
- c) clearance gaps for maintenance and cleaning;
- d) movement of machinery and material;
- e) health and safety at the work station;
- f) prevention of emissions hazardous to health at the work station.

5.2.3 Linked equipment

The risk assessment shall consider the interfaces to mechanically and/or control-related linked equipment. Respective instructions and safety measures for the interfaces shall be given in the Information for use, e.g.:

- a) machinery/equipment/devices listed as not covered by Clause 1;
- b) fire alarm system and extinguishing system;
- c) energy and media supply (e.g. compressed air, gas, steam);
- d) auxiliary equipment and systems (e.g. measuring equipment/system);
- e) material feeding and removal.

5.2.4 Structural assembly

The manufacturer shall undertake and record design calculations to show that the structural assembly (e.g. steel sections, auxiliaries) which forms part of the equipment is adequate to withstand the load under intended use.

5.2.5 Safety layout

The manufacturer shall prepare a safety layout document of the rolling mill. The safety layout shows the spatial arrangement of safety related elements and areas along the rolling mill and shall include a key.

The safety layout shall be part of the Information for use. An unambiguous relationship shall be established between the information provided in the safety layout and the Information for use.

Specific issues, in particular interfaces like escape routes (of the plant/building) or fire extinguishing devices have to be jointly clarified between manufacturer and user.

Where applicable, the following shall be shown:

- a) danger zones (related to single and/or interconnected machinery) (see 3.3);
- b) areas with specific residual risks, e.g. influence of asphyxiant gases, as due to CO₂-extinguishing installation (see Table 4), radiation;
- c) safeguards which prevent access to hazardous areas of the rolling mill;
- d) safety access;
- e) possibility of escape;
- f) local control devices or stands with safety-related functions;
- g) emergency stop devices;
- h) warning devices and safety signs;
- i) areas where no main routes are allowed.

5.2.6 Safety signs and warning devices

When machinery and equipment of rolling mills present residual hazards to personnel, safety signs according to EN ISO 7010 and warning devices according to EN 61310-1 shall be used. They shall be so installed, that they are perceptible before accessing/reaching the zone where the danger exists.

An accumulation of safety signs and warning devices should be avoided as this reduces the effectiveness and thus attention of the individual devices.

Any written or verbal information on safety signs or warning devices should be expressed in the official language or languages of the country.

The meaning of safety signs and warning devices shall be described in the Information for use (e.g. to the hazard it refers, indication of the affected area).

Plant-related warning devices shall be shown in the safety layout (see 5.2.5).

Graphical symbols shall be in accordance with ISO 3864-1 and/or EN ISO 7010.

Danger signals shall be in accordance with EN ISO 7731 and/or EN 842 and/or EN 981.

The manufacturer shall not rely upon safety signs and warning devices alone to reduce hazards in case of significant risks.

5.2.7 Personal protective equipment (PPE)

The manufacturer shall give information in the Information for use (see Clause 7) on the hazards that require the use of PPE (e.g. noise, hazardous substances, heat).

5.2.8 Loss of energy and failure of controls

Possible hazards due to energy loss (hydraulic, pneumatic, electric) and/or failure of controls shall be considered in the risk assessment and respective measures shall be provided. An emergency energy supply (e.g. emergency power supply, pressure accumulator) can be used as temporary measure to bridge the gap till the machine is in safe condition. Residual risks shall be listed in the Information for use together with compensational safeguarding measures.

In case of re-supply of energy after interruption, any unexpected start-up shall be avoided, see EN ISO 14118.

Safety-related control systems and devices shall comply with 5.2.20.

5.2.9 Work stations and assigned modes of operation

5.2.9.1 General

Work stations like control stands, pulpits, material inspection stands as well as service floors and underground areas, to which personnel is required to have access for operating the rolling mill, shall be easily and safely accessible.

Good visibility from operators' position to the operated equipment shall be ensured if risks can be caused by operating the equipment, e.g. during maintenance. If required, visual aids (e.g. closed circuit television (CCTV), mirrors) shall be provided.

The overruling from different control stands or devices shall be prevented (according EN 60204-1:2006, 9.2.7.4).

5.2.9.2 Characteristic tasks and conditions for exemplary modes of operation and repair

Table 1 shows characteristic tasks and conditions for exemplary modes of operation and repair.

Table 1 — Characteristic tasks and conditions for exemplary operating modes

	Operating modes(s) (see 3.25)			Repair
	Special modes (e.g. enabling mode, inching mode)	Safe stop mode	Normal production mode	
Access to safeguarded area (see NOTE 2)	Allowed (under certain conditions, see 5.2.11)	Allowed (under certain conditions; see 5.2.11.2)	Denied	Allowed (under certain conditions; see 5.2.11.5)
Activity	e.g. service, replacing tools, adjusting, remove cobbled product (see NOTE 1)	e.g. inspection, remove cobbled product, manually adjusting (see NOTE 1)	Production control from the pulpit	All activities do not require energy. (Functional test shall be carried out under safe conditions as per 5.2.11.6)
Machine operating status	No automatic controlled movements possible (see 3.24.3)	Initiation of movements not possible	Normal production	Off
Kinetic energy	0	0	> 0	0
	> 0 (under certain conditions, see 5.2.11)			
Isolation and energy dissipation (according to EN ISO 14118:2018, 3.3)	No	No	No	Yes
NOTE 1 Cobble removal is carried out in the mode “safe stop”. In addition, “special modes” can be used to assist the removal. NOTE 2 Sources not mentioned in Table 1 (e.g. radiation sources) are handled in conjunction with Table 4.				

During safe stop mode additional measures have to be taken to isolate or dissipate potential energy, if necessary.

NOTE An example of different modes of operation defined for segregated areas is shown in Annex E, Figure E.1.

5.2.9.3 Control stand (fixed, local)

The location of a control stand shall be in an area where the operator is not endangered.

5.2.9.4 Portable control device (wired or wireless)

Where a direct view of an operator to an area is necessary e.g. because of moving equipment, and a direct view is not possible from a (fixed) control stand, a portable control device shall be provided. The same result can be achieved by means of a fixed control stand in combination with a portable enable control.

Any interruption of the connection between the portable control device and the control system shall stop the movement/function as quick as possible.

5.2.10 Enabling control device and hold-to-run control device

5.2.10.1 General

If safety functions and/or safety measures are not available for certain operations (e.g. access doors open, fences are not foreseen), then, where necessary, the manual control of such operations shall be carried out by start control devices together with enabling control devices (e.g. enabling button) and/or hold-to-run control devices.

5.2.10.2 Enabling control device

The enable control (enabling mode) shall be in accordance with EN ISO 12100:2010, 6.2.11.9 and EN 60204-1:2006, 9.2.4, 9.2.5.2 and 9.2.6.3.

a) Requirements to enabling control devices:

- 1) Does not trigger movements, but only releases them;
- 2) Requirements of EN 60204-1:2006, 10.9 shall be complied;
- 3) Losing the enabling command (e.g. release a button) shall bring the movement to a standstill in the shortest possible time without causing additional hazards;
- 4) From the place of operation, the full overview over the released movements and thus potentially endangered persons, shall be given directly or with the help of visual aids. If the person does not have a full overview over the released movements (e.g. standing on the operating side of a mill stand), the access to the not visible area (e.g. drive side of a mill stand) is not permitted. But if an access to this area is necessary (full view over the released movements necessary), an additional enabling device shall be provided and actuated;
- 5) The enabling button at a control stand shall have two switching positions, and three switching positions on a portable control device.

b) Requirements for start control devices for initiating movements:

- 1) Together with an enabling control device, movements are triggered, but no automatic control can be started;
- 2) The start control device itself has no safety function.

5.2.10.3 Hold-to-run control device

5.2.10.3.1 Fixed hold-to-run control device

The following requirements shall be met:

- a) 5.2.9.1 and 5.2.9.3 shall be considered;
- b) the release shall bring the movement to standstill in the shortest possible time.

5.2.10.3.2 Portable hold-to-run control device

The following requirements shall be met:

- a) 5.2.9.4 shall be considered;
- b) the release shall bring the movement to standstill in the shortest possible time.

5.2.11 Access to and presence in danger zones

5.2.11.1 General

When access of authorized personnel to danger zones under operational conditions is necessary, appropriate safety measures and/or intervention procedures according to EN ISO 12100:2010, 6.3.2.4 shall be applied (see also 4.1).

In addition, the following shall be at least considered:

- a) In general, rolling mills shall be safeguarded in such a way that hazardous situations arising from access of persons shall be prevented.
- b) Any type of safeguarding (see EN ISO 12100:2010; 3.19) shall be accessible for inspection and maintenance purposes and protected against damage under foreseeable conditions. In particular, it must be sufficiently resistant to function reliably.
- c) Where dangerous movements take place, (e.g. coiling, material or equipment in motion, coil transport) access shall be prevented by protective devices (e.g. interlocked doors) or allowed in a safe way according d).
- d) Conditions for staying/working:
 - 1) hazardous movements/functions shall be stopped. If movements are necessary, they shall be carried out by a hold-to-run control and, where applicable, enabling operation with full view over the danger zone, see 5.2.10;
 - 2) measures to prevent hazards due to stored energy shall be provided (see 5.2.18).
- e) Conditions for restart, e.g. access doors are closed and acknowledged (i.e. it shall be ensured that no person is inside the danger zone).

- f) For access to the rolling mill (even to areas without a safety access, e.g. removed fences) to carry out maintenance work (see 3.10) a concept for safe access and safe working procedures shall be defined. Measures to disconnect the equipment from the energy source shall be implemented and the concept shall be described in the Information for use:
 - 1) Service, inspection and functional test, see 5.2.11.4 and 5.2.11.6;
 - 2) Repair/reconditioning see 5.2.11.5.
- g) If possible, remote monitoring (e.g. cameras, mirrors and probes) shall be used to make personnel access unnecessary.
- h) Warning signs shall be installed so that they are also visible from outside of the danger zone.
- i) Access to under floor areas shall be considered in the individual risk assessment. Possible hazardous situations in under floor areas shall be dealt with according to the requirements of Clause 5.2.11.
- j) The manufacturer shall specify in the Information for use the conditions under which access to the danger zones of the plant shall be permitted, including details about preventive measures like personal protective equipment (PPE), use of handling tools, etc.

5.2.11.2 Safety access

A safety access is an access into a danger zone monitored by the safety-related control system (see 5.2.21).

If access is detected, the measures according to 5.2.11.1 d) shall be performed by the safety-related control system, as far as applicable.

NOTE Examples for monitoring systems are, e.g. interlocked guards, light barriers, trip devices.

5.2.11.3 Access to rotating/moving parts

In general, drive shafts, coupling, belts and chains which are accessible while rotating/moving shall be guarded in accordance with EN ISO 14120 and EN 13857. Drive shafts and couplings shall be designed with a smooth surface without protruding parts except where they are operational essential.

Accessible rotating/moving parts initiated by an enabling control do not need a guard, if the requirements of 5.2.10.1 and 5.2.10.2 are considered.

5.2.11.4 Service and inspection of the equipment

Access to danger zones is only permitted for authorized persons after the operation of the equipment has been stopped.

A safe stop shall be provided, or the equipment shall be disconnected/isolated according EN ISO 14118.

Remaining risks, e.g. stored energy, shall be isolated or reduced to a permissible level. Based on a risk assessment, it may be necessary to take additional measures, e.g. use of safety bolts, energy isolation or organisational measures.

The requirements of this sub clause are also valid for removing cobbled material and cleaning after strip break.

An exception is only possible if the requirements of 5.2.11.6 are complied with.

5.2.11.5 Reconditioning or repair

Reconditioning or repair work is only permitted for authorized persons after the operation of the equipment has been stopped, the equipment has been disconnected from all energy sources and potential energy has been released or secured. The measures provided shall be in accordance with EN ISO 14118 and organisational measures shall be described in Information for use.

NOTE For description of repair work, see Clause 8.

5.2.11.6 Functional tests of the equipment in the framework of maintenance

Functional tests shall be carried out under safe conditions.

Where functional tests are to be carried out with the protective measures being disabled, the technical prerequisites and/or descriptions for the following compensation measures shall be provided:

- a) Dangerous movements not necessary for the functional tests shall be safely prevented, e.g. provide possibilities for disconnecting, e.g. lockable switch, seal-off or mechanical safeguarding; and
- b) Relevant emergency stop circuits shall be operational; and
- c) Provide safe position for the control stand or portable control device outside the effective area of the hazard, with full view over the hazard point.

Other measures may be necessary, such as, e.g.:

- d) safely-limited speed;
- e) reduced energy (due to speed, torque, force, pressure);
- f) control of hazardous movements by a portable control device;
- g) enabling mode;
- h) provision for optical warning devices (see 5.2.6) and/or protective barriers when working on systems with any kind of radiation;
- i) temporary guards;
- j) organizational measures.

5.2.12 Safeguarding

Any kind of safeguarding (see EN ISO 12100:2010; 3.21) shall be accessible for inspection and maintenance and protected against damage under foreseeable conditions. In particular, it shall be sufficiently robust to operate reliably.

5.2.13 Guards

Guards used to prevent access to a danger zone shall be selected according degree and frequency of permitted access, e.g. enclosure or distance guard, fixed or movable with interlock. Interlocking systems shall meet the requirements of EN ISO 14119.

The guards shall conform to EN ISO 14120, EN ISO 13857 and EN ISO 13854. The same applies analogously for design elements that take over the function of guards.

Regarding the safety distances described in EN ISO 13857, the distance from the base to the bottom edge shall not exceed 180 mm. The minimum height for distance protection devices (e.g. perimeter fences, protective structures) shall be at least 1 400 mm.

As an exception, the height of guards, used to prevent the changeover from one danger zone to another, or the height of guards at places, where due to feeding or removing material to or from the rolling mill (by crane, fork lift etc.) higher guards are likely to be damaged, may be reduced to a minimum of 1000 mm in accordance with EN ISO 13857 (i.e. an additional safety measure shall be considered).

There is no necessity for fixing guards (e.g. by screws) or guarding (e.g. covers) which could be removed only by auxiliary devices (e.g. cranes) due to the heavy weight. For reinstalling it shall be ensured by design that the guard is centred at its foreseen position.

If production processes shall be observed, the corresponding guards shall allow permanent sufficient visibility without disturbing influences (e.g. reflections).

NOTE This requirement is met, e.g. by a matt dark mesh.

5.2.14 Electro-sensitive protective equipment

Electro-sensitive protective equipment that is used to detect access to danger zones and dangerous functions shall be selected according to the spatial and functional conditions. In particular, it shall be ensured that the access is detected at an early stage so that the time to reach any danger point is longer than the time required for stopping (according to EN ISO 13855).

Electro-sensitive protective equipment that is used to detect positions of equipment or material shall be deployed in such a way that they will be activated only by means of the intended detection (e.g. differentiation of persons and material during muting (muting, see EN ISO 13849-1), actuation of inductive safety sensors only by means of the provided counterpart).

Electro-sensitive protective equipment shall be in accordance with EN 61496-1.

Before restarting the rolling mill, the leaving of the danger zone shall always be confirmed by an operator.

5.2.15 Guard-rails

Guard-rails are to be considered as means to deter or impede access to hazardous areas. They are a physical obstacle which only reduces the probability of access but not totally prevents it (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 material).

Guard-rails shall 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 to zones where only residual risks exist. These are, e.g. zones where equipment with movements can be operated only in manual mode (hold-to-run function) with full view to the moving equipment.

Guard-rails shall conform to EN ISO 14122-3. In addition, the manufacturer shall give instructions in the information for use (see Clause 7) about the foreseen restrictions for access to the areas surrounded by the guard-rails and about the nature of the existing residual risks.

5.2.16 Preconditions for movements of equipment not causing significant hazards

Hazards due to movements and functions of equipment can be classified as not significant if the design of the equipment is such that a person could not be injured.

The application of guards or sensitive protective equipment on plants and plant parts are not necessary, if the individual risk assessment shows an appropriate result and the following minimum requirements a) to h) are met. These movements and functions may be triggered by a non-safety control system without additional safety function.

- a) Access into other hazardous areas, i.e. with a higher risk potential, shall be detected or prevented by protective devices;
- b) The area where movements take place shall be marked (e.g. by a black and yellow hatching);
- c) Drawing in or crushing shall be avoided by design (e.g. underride guard);
- d) Sufficient space shall be available to get away from the movement and no falling hazards existing (e.g. these hazards are prevented by guard-rails);
- e) The speed of accessible movements shall be limited by design, i.e. it cannot be exceeded by a malfunction of the control system, and shall not exceed 200 mm/s;
- f) The accessible movements shall be controlled manually in jog mode. At the place where the movements are operated an emergency stop shall be available;
- g) At the place where the movements are operated a full overview over these movements shall be ensured, e.g. by direct view, mirrors or CCTV;
- h) Appropriate safety signs shall be placed.

Where the above specified requirements are not fully met, additional protective measures (e.g. enabling mode) have to be defined in the risk assessment.

5.2.17 Determination of required Performance Level (PLr)

It is recommended to consider risk reduction by other technical measures (e.g. safe design, fixed guards) independent of the control system or additional safety functions when determining the PLr of the intended safety function.

For the individual risk assessment, the following criteria of Table 2 shall be used.

Table 2 — Determination of PLr

Hazards	EN ISO 13849-1:2015 Annex A, A.2 Risk parameter at least			PLr at least
	S	F	P	
The significant hazards (according to Table 3) like crushing, entanglement, drawing-in or getting caught caused by electrically, pneumatically or hydraulically driven movements dealt with in this standard may in any case lead to serious injuries.	S2	F1-F2	P1-P2	c
The determination of the frequency and/or exposure times to hazard shall be based on the intended use of the respective machinery.	/	F1-F2	/	/
If there is no production or machine related activities which require, that a person brings himself or parts of his body into danger, the possibility of avoiding the hazard is given.	S1-S2	F1-F2	P1	a
In case, that the source of significant hazards is ionizing radiation, there is, due to the non-visibility of radiation, no possibility of avoiding the hazard.	S2	F1-F2	P2	d

The determination of the frequency and/or exposure times to hazard shall be based on the intended use of the respective machinery. F (frequency and/or exposure) shall be in accordance with EN ISO 13849-1:2015, A.2.2:

- F1 shall be chosen if the accumulated exposure time does not exceed 1/20 of the overall operating time and the frequency is not higher than once per 15 min.
- F2 shall be chosen, if the frequency is higher than once per 15 min.

5.2.18 Stored energy

Risks due to stored energies shall be considered in the risk assessment.

a) Kinetic energy

Any significant risk due to moving machine parts or moving material shall be considered. Access shall not be possible until safe conditions have been reached (i.e. delay time after switching off, sufficient distance of access door, speed monitoring).

b) Potential energy

Potential energy (e.g. spring force, pressure or weight force) may lead to unexpected movements, falling parts or projection of high-pressure fluids.

To reduce any risk due to failing or breaking parts of the construction (e.g. bolts, supports, pipes) the parts shall be designed for the intended use, compliant to good engineering practice.

Where sudden movements due to vanishing pressure/power may occur (i.e. falling of tools, machine parts or material because of an insidious loss of clamping pressure) at places being accessed regularly to operate the machine, constructive and/or technical safety measures shall be taken to reduce the risk.

Where vanishing pressure/power or other reasons due to stored energy could cause only slow movements (e.g. internal leakage of the cylinder or valve) and there is no or low risk (e.g. due to sufficient distance between moving and fixed parts), no further measures are required.

5.2.19 Mechanical restraint devices

In order to avoid hazards caused by unexpected movements due to stored energies, mechanical restraint devices shall be selected to hold the equipment/tool in a safe position during maintenance or troubleshooting. Those devices can be, e.g. safety bolts, latches, scotches or brakes.

Where automatically operated safety bolts are used, e.g. operated by hydraulic cylinders, they shall be monitored by the control system in their end position and any further operation shall only be possible if the correct position is confirmed.

Where safety bolts or latches are set by hand, they shall be clearly identifiable (e.g. by different shapes) and installed directly on the equipment to be protected (e.g. by a chain). The installation of mechanical restraint devices shall be possible from a position where the person in charge is not endangered by movements due to stored energy.

Safety bolts shall be sufficiently dimensioned to withstand loads due to gravity and possible movements. Strength verification by calculation of the dimensioning shall be provided.

Where brake systems are used to hold equipment in a defined position, they shall be designed so that they are held in the holding position in case that they are not energized.