



BSI Standards Publication

Safety of machinery — Safety requirements for strip processing line machinery and equipment

National foreword

This British Standard is the UK implementation of EN 15061:2022. It supersedes BS EN 15061:2007+A1:2008, which is withdrawn.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

Safety of machinery - Safety requirements for strip processing line machinery and equipment

Sécurité des machines - Prescription de sécurité pour machines et installations de traitement des bandes

Sicherheit von Maschinen - Sicherheitsanforderungen an Bandbehandlungsanlagen und Einrichtungen

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
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CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

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European foreword

This document (EN 15061:2022) 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of an identical text or by endorsement, at the latest by September 2022, and conflicting national standards shall be withdrawn at the latest by September 2022.

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This document supersedes EN 15061:2007+A1:2008.

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Introduction

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

This document is not applicable to strip processing lines manufactured before the date of its publication.

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.

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 operators/ 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 in the drafting process of this document.

1 Scope

This document defines the general safety requirements of strip processing lines.

This document applies to:

Strip processing lines for treating metal strip, from

- coil take-over-point of the entry section (terminal equipment, see 3.2) through the
- process (processing and terminal equipment, see 3.3 and 3.2) up to the
- coil take-over-point of the exit section or interface to other lines (terminal equipment), see Figure 1.

Terminal equipment for:	Processing and terminal equipment for:
Entry section	Chemical and/or electro-chemical treatment lines (e.g., pickling, cleaning) Hot dipping lines Electro plating lines Coating lines (e.g., roll coating) Annealing lines
Exit section	

Figure 1 — Terminal and processing equipment

NOTE 1 The aforementioned processes can also occur in combination.

If the aforementioned processes will be combined with processes which are not covered by the scope of this document, this document can be used as a guideline.

NOTE 2 Thermo process equipment integrated in strip processing lines is covered by the EN 746 series. For dryers and ovens, in which flammable substances are released, EN 1539 applies.

This document does not cover:

- thermo process equipment, e.g. in accordance with the EN 746 series;
- dryers and ovens in accordance with EN 1539;
- coil transporting system before coil take-over-point at the entry section and after coil take-over-point at the exit section, e.g. hook conveyors, overhead cranes, fork lift and railway trucks and other vehicles;
- acid regeneration plants;
- regeneration plants which are not integral part of the strip processing line;
- storage equipment for coils;
- rolling mill stands (i.e. skin pass and reduction stands) according to EN 15094;

- rollshop equipment;
- separate process technology (e.g. compressed air system, treatment of water and treatment of rolling lubricant);
- separate cleaning system for exhaust air;
- firefighting systems.

NOTE 3 Protection of persons in case of using asphyxiant gases used in firefighting system is covered by this document, see Annex C.

This document deals with foreseeable significant hazards, hazardous situations and events relevant to strip processing lines, when 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, use, de-commissioning and maintenance periods, as well as in the event of foreseeable failures or malfunctions that can occur in the equipment.

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

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 415-8, *Safety of packaging machines - Part 8: Strapping machines*

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 689, *Workplace exposure - Measurement of exposure by inhalation to chemical agents - Strategy for testing compliance with occupational exposure limit values*

EN 746 (all parts), *Industrial thermoprocessing equipment*

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

EN 12198 (all parts), *Safety of machinery - Assessment and reduction of risks arising from radiation emitted by machinery*

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 13480 (all parts), *Metallic industrial piping*

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

EN 15154-2, *Emergency safety showers - Part 2: Plumbed-in eye wash units*

EN 15154-5, *Emergency safety showers - Part 5: Water overhead body showers for sites other than laboratories*

EN 15154-6, *Emergency safety showers - Part 6: Plumbed-in multiple nozzle body showers for sites other than laboratories*

CLC/TR 60079-32-1:2018, *Explosive atmospheres - Part 32-1: Electrostatic hazards, guidance*

EN 60204-1:2018, *Safety of machinery - Electrical equipment of machines - Part 1: General requirements (IEC 60204-1:2016, modified)*

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

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

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

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

EN 61800-5-2:2017, *Adjustable speed electrical power drive systems - Part 5-2: Safety requirements – Functional (IEC 61800-5-2:2016)*

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

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

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 10218-1, *Robots and robotic devices - Safety requirements for industrial robots - Part 1: Robots (ISO 10218-1)*

EN ISO 10218-2, *Robots and robotic devices - Safety requirements for industrial robots - Part 2: Robot systems and integration (ISO 10218-2)*

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

EN ISO 11064-2, *Ergonomic design of control centres - Part 2: Principles for the arrangement of control suites (ISO 11064-2)*

EN ISO 11064-3, *Ergonomic design of control centres - Part 3: Control room layout (ISO 11064-3)*

EN ISO 11064-6, *Ergonomic design of control centres - Part 6: Environmental requirements for control centres (ISO 11064-6)*

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 11553-1, *Safety of machinery - Laser processing machines - Part 1: Laser safety requirements (ISO 11553-1)*

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

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 14120:2015, *Safety of machinery - Guards - General requirements for the design and construction of fixed and movable guards (ISO 14120:2015)*

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)*

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)*

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

ISO/TR 22100-4:2018, *Safety of machinery — Relationship with ISO 12100 — Part 4: Guidance to machinery manufacturers for consideration of related IT-security (cyber security) aspects*

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:

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

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

3.1

strip processing line

assembly of equipment for treating metal strip (surface treatment and/or to change the metal properties) in which single machines (as described in 3.2 and 3.3) are linked by strip transport facilities and/or the strip itself, including ancillary equipment

3.2

terminal equipment

equipment for moving, guiding, connecting, dividing and trimming the metal strip, coil handling equipment and related ancillary equipment like hydraulic and pneumatic equipment and systems

3.3

processing equipment

equipment for surface treatment and/or modifying the metal strip properties

3.4

safety layout

graphic overview of the strip processing line with the arrangement of specific safety-related elements and areas

Note 1 to entry: 5.2.5 specifies the safety related elements to be shown on the safety layout.

3.5

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]

3.6

take-over-point

point(s) where the strip processing line is connected to incoming/outgoing material (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.

3.7

main route

marked traffic route

3.8

safeguard(ing)

guard or protective device

[SOURCE: EN ISO 12100:2010, 3.26]

3.9

trained person(nel)

skilled person with system knowledge, background knowledge, experience and/or ability to perform a specific task and are aware of the hazards related to their duties

3.10

authorized person(nel)

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

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

3.11

maintenance

combination of service, inspection, reconditioning 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 strip processing line can perform the required function (including safety requirements).

3.11.1

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 (e.g. rolls, knives).

3.11.2

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: 3.11.2 does not cover "strip inspection", see 3.14.

3.11.3

reconditioning

foreseeable measure(s) to return to the nominal condition

Note 1 to entry: Foreseeable measures to replace worn parts or parts having expired the foreseen lifetime (could require dismantling/disassembling). These parts should meet manufacturers' specification.

3.11.4**functional test**

checking 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.

3.12**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.

3.13**strip**

metal strip in the production process, supplied and removed as coil

3.14**strip inspection**

observe and assess the current condition of the material

3.15**cobbling**

strip leaving its intended path

Note 1 to entry: Colliding with e.g. parts of the equipment is possible.

3.16**pulpit**

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

3.17**control stand**

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

3.18**portable control device**

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

3.19**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]

3.20**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]

3.21

control mode

single machines or groups of linked machines of strip processing lines can function under different control modes

Note 1 to entry: This document distinguishes between control mode(s) and operating mode(s) because there is neither a common understanding nor a definition in EN ISO 12100 and EN 60204-1. The operating modes (see 3.22) corresponds to the "control mode" of EN ISO 12100:2010, 6.2.11.9.

Note 2 to entry: For examples, see Figure D.1.

3.21.1

manual control mode

3.21.1.1

hold-to-run control

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

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

3.21.1.2

single function

specific functions are started and/or stopped by an operator

3.21.2

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.

3.21.3

automatic control

cycles of successive or parallel sequences, once initiated by the operator

Note 1 to entry: If no interruption takes place by an operator, the sequences are repeated as long as the running conditions are met.

3.22

operating mode

state of the control system allowing to operate the strip processing line under defined line 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.

3.22.1

special mode

3.22.1.1

enabling mode

operating machine functions with an additional enabling control device (as per 3.19)

3.22.1.2

inching (jog) mode

operation of machine functions using a hold-to-run control device (as per 3.20)

3.22.2**safe stop (mode)**

movement of the involved equipment is prevented through the control system

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

Note 2 to entry: Safe stop is not sufficient as a safety measure to perform reconditioning or 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.

3.22.3**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 3.11 is not covered.

3.23**reduced speed**

speed that is reduced to minimize the hazardous potential without safety-related speed monitoring

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.

3.24**safely-limited (strip) speed****SLS**

exceeding of a predefined speed limit is safety-related prevented, e.g. according to EN 61800-5-2:2017, 4.2.4.5

Note 1 to entry: Linear or rotational speed.

3.25

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 according to EN ISO 14118:2018, 3.2.

3.26

remote access

access from outside the line via interface to control systems of the strip processing line, e.g. for software update

3.27

ionizing radiation

x-ray radiation or radiation emanating from radioactive sources

3.28

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.

3.29

user

company operating the plant

4 List of significant hazards

4.1 General

The hazards, hazardous situations and events identified by risk assessment as significant and which require action to eliminate or reduce the risk are listed in Clause 5.

In general, risks and associated hazards are production and plant related. Due to the design variety of strip processing lines (i.e. different combination of strip processing line equipment, covered or not covered, see Clause 1), an individual risk assessment shall be carried out in any case, considering the special features of the strip processing line in question and considering the safety requirements specified in this document.

Significant hazards identified in this individual risk assessment but not dealt with in this document shall be avoided respectively reduced by applying the principles of EN ISO 12100.

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 (see also 5.2.3), e.g. linked machinery not covered by the scope like skin pass mills and furnaces. Respective instructions and safety measures including control requirements for interfaces shall be given in the Information for use.

It is recommended to adjust the position of the strip processing line in relation to the environment (e.g. other machinery/lines and/or building parts) with the user.

5 Safety requirements and/or protective/risk-reducing measures

5.1 General

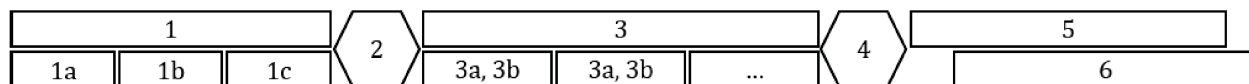
Life phases of a strip processing line are the following (see Figure 2):

- 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 strip processing line has a service life of several decades. In the course of the years, strip processing lines are repeatedly modernized and adapted to changed technical requirements. Thus, the condition of a strip processing line at the date of disabling is not known. Refer to 7.4.3.

- d) disposal:

Usually, a strip processing line 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.

**Key**

- | | |
|--|---|
| 1 manufacture (period of time) | 3 operation (period of time) |
| 1a design, manufacture, (pre-)assembly
(at the manufacturer's premises) | 3a production |
| 1b transport | 3b setting, adjustment, maintenance, etc. |
| 1c assembly, commissioning, trial run
(at the operator's site) | 4 disabling (point in time) |
| 2 putting into service (CE) (point in time) | 5 disassembly (period of time) |
| | 6 disposal (period of time) |

Figure 2 — Schematic representation of the life phases of a strip processing line

5.2 Requirements for design, planning and risk assessment

5.2.1 General

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

The manufacturer shall include in the information for use instructions required for a safe operating procedure for the foreseen operating modes. Points for energy isolation and dissipation shall be described in accordance with EN ISO 14118.

It is assumed that that strip processing lines are operated and maintained by trained personnel (see 3.9).

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

Where frequent access is planned by the manufacturer, e.g. for setting, maintenance, cleaning, production, permanent means of access shall be provided.

It is not required to provide permanent means of access to every part of the line 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, vibration, 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.

Means of access, such as stairways, walkways, platforms, etc. shall be in accordance with EN ISO 14122 (all parts).

5.2.2 Planning of strip processing lines

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, to ensure good placement and safe operation:

- accessibility;
- possibility of escape from the strip processing line;

- 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) exhausting system, 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 of the strip processing line. The safety layout shows the spatial arrangement of safety-related elements and areas along the strip processing line and shall contain 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 3.5;
- b) areas with specific residual risks (e.g. by the influence of asphyxiating gases, as due to a CO₂ extinguishing system); radiation;
- c) safeguards which prevent access to hazardous areas of the strip processing line;
- d) safety accesses;
- 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 strip processing lines 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 (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 and 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 strip processing line 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 5.2.21.

5.2.9 Work stations and assigned modes of operation

5.2.9.1 General

Work stations like control stands, pulpits, strip inspection stands and service floors, to which personnel is required to have access for operating the line, shall be easily and safely accessible (see also 5.2.1).

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.

In the case of machinery with more than one control position, measures shall be taken to ensure that the initiation of operation from different control positions does not lead to a hazardous situation (according to EN 60204-1:2018, 9.2.4.4).

5.2.9.2 Characteristic tasks and conditions for exemplary operating modes

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

Table 1 — Characteristic tasks and conditions for exemplary operating modes

	Operating modes (see 3.22)			Repair
	Special modes (e.g. enabling mode, adjustment)	Safe stop mode	(normal) Production	
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 operation, remove cobbled product (see NOTE 1)	e.g. inspection, remove cobbled product (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 3.21.3)	No movements possible	Normal production	Off
Kinetic energy	0	0	> 0	0
	> 0 (under certain conditions, see 5.2.11)			
Isolation and energy dissipation (according to 3.3 of EN ISO 14118:2018)	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 Tables 4 and 5.

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

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 60204-1:2018, 9.3.6, 9.2.3.2 and 9.2.3.9.

a) Requirements for enabling control devices:

- 1) Does not trigger movements, but only releases them;
- 2) Requirements EN 60204-1:2018, 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 the equipment), the access to the not visible area (e.g. drive side of the equipment) is not permitted. But if an access to this area is necessary (full view over the released movements necessary), an additional enabling control 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) Releasing the device 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) Releasing the device 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, strip processing lines shall be safeguarded in such a way that hazardous situations arising from access of persons to the line 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 shall be sufficiently resistant to function reliably.
- c) Where dangerous movements take place, e.g. coiling, strip in motion, coil transport (this does not apply to threading after strip breakage, see g) hereafter) access shall be prevented by protective devices (e.g. interlocked doors) or allowed in a safe way according to d). For exceptions see f) hereafter.
- 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. See f) for exceptions;
 - 2) unexpected start-up/restart shall be avoided;
 - 3) measures to prevent hazards due to stored energy shall be provided (see 5.2.18).
- e) As a condition for restart access doors have to be closed and acknowledged (i.e., it shall be ensured that no person is inside the danger zone).
- f) Access into a danger zone with strip in motion, e.g. during production, shall take place only under special conditions in case of material inspection, threading and inserting/removal intermediate layers. Access to the strip shall be permitted only with SLS at 30 m/min max. strip speed. In case of lines which are processing material with limited stiffness (which means, that there is no significant risk for operating personnel when being hit/touched by material), the SLS may be defined at a higher level depending on the limitations of the state-of-the-art drive control systems and if the production process requires manual assistance in the danger zone. The area where access to the moving strip is possible, shall not contain rotating or moving parts (e.g. rolls, shafts) or these parts shall be covered, or movement shall be stopped or hold-to-run control/enabling mode shall be provided. Additional protection in case of lateral access to the strip by, e.g. guard-rails in front of the strip and provision of guards to prevent contact with strip edges in case of slip, trip, fall. Any hazard due to strip break

shall be considered in the risk assessment. If the risks cannot be reduced to an acceptable level according to EN ISO 12100:2010, 5.6.2, access to the strip is not allowed.

- g) For access to the plant (even to areas without a safety access, e.g. removed fences) to carry out the necessary steps for threading/unthreading of the strip, e.g. after strip break, a concept for safe working procedures shall be defined considering the following conditions (not applicable to production-related threading/unthreading):
- 1) Provision of devices able to realize safe stop or disconnection/isolation, e.g. lockable switch (according to EN ISO 14118:2018);
 - 2) Local lockable switch to activate safe stop, where necessary;
 - 3) Description of organizational measures in the instruction for use, e.g. lock the energies which could cause a danger;
 - 4) For moving the strip whilst threading only: Temporary measures (e.g. authorized person(nel) with full overview over the area and the possibility to stop the movement) to prevent dangerous situations shall be applied.

The concept shall be described in the Information for use.

- h) For access to the plant (even to areas without a safety access, e.g. removed fences) to carry out maintenance work, a concept for safe working procedures shall be defined and 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.
- i) If possible, remote monitoring (e.g. cameras, mirrors and probes) shall be used to make personnel access unnecessary.
- j) Warning signs shall be installed so that they are also visible from outside of the danger zone.
- k) Access to under floor areas shall be considered in the individual risk assessment.
- l) The manufacturer shall specify in the Information for use the conditions under which access to the danger zones of the line shall be permitted, including details about preventive measures like personal protective equipment (PPE), use of handling tools, etc.

The possibility of access should be provided according to EN ISO 14120:2015, 6.4.

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) and f) 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 ISO 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, e.g. normal stop in acc. with Annex A, Table A.2.

Additionally, a safe stop shall be ensured as defined by the risk assessment (see Table 4 and Table 5). The related risks (e.g. stored energy, radiation) shall be isolated or reduced to a permissible level.

Based on a risk assessment, it may be necessary to take additional measures, e.g. means for stored-energy dissipation or restrain as mentioned in EN ISO 14118:2018, 5.4.

The requirements of this subclause 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 organizational 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 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 cut-off, 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, e.g. hold-to-run control;
- 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.

5.2.11.7 Requirements for strip inspection stands

Where a regular strip inspection is intended, the significant hazards and safety measures at strip inspection stands, as listed under 5.3.13, shall be considered.

Where a risk due to strip break exists, guards shall be provided to protect exposed personnel.

The position for visual inspection shall be out of reach of the source of danger (e.g. by means of mirrors, suitable illumination of the strip, Figure D.6). Access shall be prevented to the area around the moving strip (e.g. fences or enclosing structures like cabins).

When closer observation of the strip is required, the following shall be applied:

- a) Access to the strip shall be permitted only according to 5.2.11.1 f);
- b) The area where access to the moving strip is possible, shall not contain rotating parts (e.g. rolls, shafts) or these parts shall be covered, see 5.2.11.2;
- c) Additional protection by, e.g. handrails around the strip (see Figure D.6) and provision of guards to prevent contact with the strip edges in case of slip, trip, fall.

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

5.2.13.1 Guards used to prevent access to a danger zone shall be selected according to 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 requirements of 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 of distance guards (e.g. perimeter fences, protective structures) shall be at least 1400 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 strip processing line (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).

5.2.13.2 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.

5.2.13.3 If production processes must 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-like protective device.

5.2.14 Sensitive protective equipment

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 greater than the time required for stopping (according to EN ISO 13855). Before restarting the line, the leaving of the danger zone shall always be confirmed by an operator.

Sensitive protective equipment that is used to detect positions of equipment or material shall be deployed in such a way that it will only 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.

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 information 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)

Table 2 hereafter is the basis for the determination of the required performance levels.

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 — Hazards and corresponding risk parameters for the determination of PLr

Hazards	EN ISO 13849-1:2015 Annex A, A.2 Risk parameter at least			PLr at least
	S	F	P	
Crushing, entanglement, drawing-in or getting caught caused by electrically, pneumatically or hydraulically driven movements	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 activity 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 is given	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 trouble-shooting. 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 access 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 the expected loads. 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.

The mechanical restraint devices shall be kept in safe position in case of power supply interruption and re-start.

5.2.20 Electrical equipment

Electrical equipment shall conform to EN 60204-1.

Manufacturer shall identify through an individual risk assessment based on EN ISO 12100 which electrical hazards are significant.

5.2.21 Safety-related control systems

Safety-related control systems and devices shall be in accordance with:

- a) EN 60204-1:2018, 9.4; and
- b) EN ISO 13849-1 and EN ISO 13849-2 or EN 62061; and
- c) EN ISO 4413 for hydraulic and EN ISO 4414 for pneumatic systems.

5.2.22 Safety-related software and parameters

Safety-related software and parameters shall be protected against unauthorized access and manipulation, e.g. by passwords on different levels. For software safety requirements see EN ISO 13849-1:2015, 4.6. In general, passwords are not passed to the user. In case those passwords are passed to the user, information shall be given in the Information for use that modifications of software and/or parameters can lead to additional hazards and thereby have an impact on the safety of the plant and can result in losing the presumption of conformity.

Safety-related software and parameters shall be verified according to Clause 6.

Furthermore, EN ISO 12100:2010, 6.2.11.7.3 shall apply.

NOTE Software modifications can be detected by using a checksum. If the original checksum is different from the current checksum, a modification has been made.

5.2.23 Remote access to control systems

Remote access can be established for purposes of maintenance, service and support.

The following requirements shall be complied with:

- a) authentication by the user, e.g. through different user profiles with personal passwords;
- b) guidelines for the remote access shall be defined, e.g. user profile, rights, time limits for access;
- c) activities capable of being carried out by remote access shall be defined;
- d) where safety-related software and parameters have been modified, a functional test shall be carried out. The manufacturer/integrator shall provide the user/operator with detailed instructions for the functional test;
- e) activities shall be carried out solely on site in co-ordination with and with direct participation of the responsible personnel according to 7.6.

Furthermore, EN ISO 12100:2010, 6.2.11.7.3 and 5.5.3.6 and ISO/TR 22100-4:2018, Table 3 shall apply.

5.2.24 Radiation and fields

5.2.24.1 Radiation emitting systems

As far as radiation emitting systems are concerned, the requirements of EN ISO 13849-1 and EN ISO 13849-2 shall be observed for risk assessment and control system design. In Addition, for measuring equipment with ionizing radiation, EN 62598 shall be applied.

In General, access to areas with dangerous emitted radiation shall be prevented by guards. Where access is possible, the emitted radiation shall be reduced to a level not causing adverse effects on persons (e.g. by the use of fixed shielding plates or by interlocks switching off the source or closing the shutter).

Operation of radiation emitting systems shall be indicated by optical warning devices. Use graphic symbol for radioactive material or ionizing radiation according to EN ISO 7010 when marking radiometric devices. Warning signs and optical warning devices shall be positioned such that the danger zone is appropriately marked.

The Information for use/assembly instructions shall point out that operation, maintenance and servicing of radiation emitting systems shall be carried out only by specially trained operating and maintenance personnel.

NOTE 1 Depending on the type of radiation, other legal provisions (e.g. for ionizing radiation or for optical radiation) might have to be observed.

NOTE 2 Systems with ionizing radiation might have to be approved by institutions appointed by the user and in compliance with locally valid prescriptions and directives. These systems might also be subject to verification in regular intervals fixed by the competent institutions.

5.2.24.2 Electromagnetic fields

Electromagnetic fields with field strengths exceeding permissible limits may affect the health of individuals, particularly through influences on medical implants.

Hazards from electromagnetic fields generated by equipment of the strip processing line shall be considered in the risk assessment of the machine and appropriate measures (for example, shielding, safety access) shall be taken to reduce the risks.

NOTE Limit values are given in the EU Directive 2013/35/EU (Electromagnetic Fields (EMF) Directive) or their national implementations.

5.2.24.3 Heat radiation and surface temperatures

In general, hot surfaces cannot be covered due to the process, i.e. hot coils or hot machine parts and special conditions and because the structure and equipment have to be cooled by the surrounding air.

Permanent or temporary work stations and main routes shall be protected against heat radiation and unintentional touching of hot surfaces, if applicable:

- a) For heat radiation, EN 12198-3 shall be considered;
- b) Surfaces which are accessible via route ways and could be touched shall have temperatures not exceeding the burn threshold for contact time and material specified in EN ISO 13732-1. If the said limits could not be kept because of technical reasons additional technical measures shall be applied, e.g. isolation, distance guard. Complementary measures shall be included in the operating/maintenance instructions, e.g. for maintenance, repair, adjustment, indication of warnings and wearing of PPE.

For maintenance work an indication of the risk and necessary actions (e.g. cooling down time, PPE) shall be given in the operating/maintenance instructions.

5.2.25 Fluid systems (hydraulic, pneumatic, cooling, lubrication and additional media systems)

5.2.25.1 General

Hydraulic systems shall be designed according to EN ISO 4413 and pneumatic systems according to EN ISO 4414.

Manufacturers of strip processing lines using fluid systems carrying or containing fluids which are likely to solidify and/or have high or low viscosity which can increase the hazard due to temperature influences, shall provide protection against temperature influences.

If technically possible, rigid piping shall be used for the hydraulic systems. Hoses can be used if, for example movements or vibrations have to be compensated.

For the design of high-pressure pipes, EN 13480 parts 1 to 5 shall be considered.

Manual shut-off devices shall be installed outside the danger zone, be accessible without risk and have a clearly indicated shut-off position.

When designing these media systems, the risks of toxic effects, substances, vapours, pressure, temperature, ignition sources, fire, explosion, noise and vibration shall be taken into account.

Information shall be given in the information for use about the specification (s) of the fluid (s) to be used.

For cooling and lubricating systems, protective measures shall be provided to reduce risks to the permissible level, e.g. extraction of fumes.

Where the risk of static charge is given, appropriate electrical grounding/equipotential bonding shall be carried out.

Where at production-related work stations/main routes, i.e., places with frequent or longer stays, a significant hazard for persons is present due to leaking/splashed media/flying hoses, coverings of flanges, fittings and hoses shall be provided and ends of flexible pipes or hoses shall be secured, e.g. with a chain.

5.3.3 (Table 4; terminal equipment) and 5.4.3 (Table 5; processing equipment) determine detailed requirements.

5.2.25.2 Media that shall be disposed from the line

The manufacturer shall inform the user about the media which have to be disposed from the line. For these media, take-over points shall be defined together with the user. This information shall be included in the Information for use.

5.2.26 Substances

5.2.26.1 General

Information on interfaces for filling and emptying the operating materials shall be specified in the information for use.

Information shall be provided in the information for use for which operating materials and consumables the strip processing line is intended. It is sufficient to describe the properties of the substances as far as they can affect the health, the environment or the safety of the line.

5.2.26.2 Maintenance of equipment containing dangerous substances

Where maintenance is required and, e.g. a risk of toxic effects, gas/dust accumulation or suffocation is given, the following information shall be given in the Information for use, as appropriate:

- a) removal of the dangerous substances, considering EN ISO 14123-1 and EN ISO 14123-2;
- b) cleaning of surfaces from residual dangerous substances;
- c) prevention of refilling the equipment by, e.g. blocking the pumps, closing the valves;
- d) ensure that there is no dangerous atmosphere, e.g. by measurement according to EN 689;
- e) use of PPE.

5.2.27 Firefighting

The necessity to install firefighting systems at strip processing lines (e.g. pulpit, hydraulic/electric rooms) shall be checked taking into account the processing conditions (e.g. use of combustible working materials or formation of combustible residues); the result shall be communicated to the user. For detailed information, see EN 12094-1, EN ISO 19353, EN ISO 15004-1 and Annex C.

5.2.28 Ergonomics

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

- a) dedicated lifting aids or anchoring points for common lifting devices shall be provided whenever frequent lifting or heavy tooling of machines is required;
- b) eyebolts or similar aids shall be fitted to heavy components to lift them; and if appropriate, they shall also be fitted with handles, hand-holds or grips with a slip-resistant (e.g. knurled) surface;
- c) work areas used for manual handling of components shall be so designed that they are free of obstructions so that the operator is not hindered in his movements; the work area shall be sufficiently spacious to handle manual loads close to the body;
- d) the ideal placement for hand wheels, levers, etc. to minimize physical effort is between 700 mm and 1 600 mm above the worker's standing level;
- e) supporting structures provided to enable machinery parts to be assembled on site shall be designed and fabricated to ensure stability, and thereby minimize manual handling;
- f) machine parts, such as electric motors, should be located on top of structural supports and shelves rather than suspended. This removes the need for manually supporting the item whilst securing it in position;
- g) slip-resistant surfaces;
- h) vibration protection as defined in 5.2.29;
- i) heat protection as defined in 5.2.24.3;
- j) lighting of the working areas shall be in accordance with EN 12464-1 (if appropriate, national regulations are expected to be applied).

5.2.29 Vibrations

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

Harmful hand-arm vibration at strip processing lines cannot be expected.

Where the risk of whole-body vibration at permanent working places is given, measurement according to EN 14253 shall be made after commissioning to verify the designed measures.

5.2.30 Noise reduction as a safety requirement

5.2.30.1 Noise reduction at source by design

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

- a) reduce impact energy (e.g. by reducing the height of fall);
- b) reduce power of impact (e.g. by dampened impact);
- c) reduce noise of gas flow (e.g. low-noise nozzles, sound absorbers);
- d) use internal damping (e.g. cast instead of steel plate structures, sandwich plate);
- e) dampening of structure-borne noise (e.g. by coating or sandwich plate);
- f) insulation of structure-borne noise (e.g. by installation of masses), vibration isolated mounting (e.g. by spring elements and dampers);
- g) 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 values from the machine in relation to other machines of the same family and not the nature of the measures themselves.

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

5.2.30.2 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 for general measures are:

- a) total or partial enclosures;
- b) shields;
- c) silencers;
- d) increased distance between source and operator.

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

5.2.30.3 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 7.4.1.1, list item c).

5.2.30.4 Noise sources and examples of noise reduction measures

One noise source of the strip processing line is the moving strip itself. The main parameters are the dimensions, the surface quality (e.g. waves, centre buckles) and the material specifications (e.g. hardness) of the strip. The main noise sources of the equipment of the strip processing line are shown in Table 3 together with exemplary design or protective measures. This table is not exhaustive. Alternative technical measures for noise reduction can be used.