INTERNATIONAL STANDARD

ISO 22291

First edition
2022-01

Safety requirements for wetlaid-nonwoven machinery

Exigences de sécurité pour les machines de production de non tissé par voie humide

Reference number
ISO 22291:2022(E)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

Foreword

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

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

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

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

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

This document was prepared by Technical Committee ISO/TC 72, *Textile machinery and accessories*, Subcommittee SC 8, *Safety requirements for textile machinery*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 214, *Textile machinery and accessories*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document was prepared simultaneously by ISO/TC 72 and CEN/TC 214, and adopted under the Vienna Agreement in order to obtain identical standards on technical safety requirements for the design and construction of wetlaid-nonwoven machinery.

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

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

— machine manufacturers (small, medium and large enterprises);

— machine designers;

— systems integrators;

— health and safety bodies (regulators, accident prevention organisations, market surveillance, etc.).

Others can be affected by the level of machinery safety achieved with the means of the document by the above-mentioned stakeholder groups:

— machine users/employers (small, medium and large enterprises);

— machine users/employees (e.g. trade unions, organizations for people with special needs);

— service providers, e.g. for maintenance (small, medium and large enterprises);

— consumers (in case of machinery intended for use by consumers).

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

The machinery concerned and the extent to which hazards, hazardous situations or hazardous events are covered are indicated in the Scope of this document. When requirements of this type-C standard are different from those which are stated in type-A or type-B standards, the requirements of this type-C standard take precedence over the requirements of the other standards for machines that have been designed and built according to the requirements of this type-C standard.

For machines or machine equipment not dealt with in this document, the designer performs a risk assessment according to ISO 12100 and provides means for reducing the risk from significant hazards. These risk reduction measures that need to be identified by the designer/manufacturer of the machinery by risk assessment are outside the scope of this document.

This document contains a summary of general safety requirements and/or protective/risk reduction measures for frequently occurring hazards of wetlaid-nonwoven machinery (see Clause 5) which apply whenever referred to in this document.

Specific hazards and corresponding specific safety requirements and/or protective/risk reduction measures for certain machine elements (e.g. winders) and their combination of wetlaid-nonwoven machines are also described (see Clause 6).

Safety requirements for wetlaid-nonwoven machinery

1 Scope

This document specifies safety requirements and means of verification for wetlaid-nonwoven machinery.

This document applies to wetlaid-nonwoven machines, including approach flow system, headbox, wire section and jet head, hydroentangling unit, dryer, finishing, quality control system (QCS), winder, drives and control system. Annex C illustrates general wetlaid-nonwoven machinery and their components.

It deals with all significant hazards, hazardous situations and hazard events relevant to wetlaid-nonwoven machines, when used as intended and under the conditions foreseeable by the manufacturer.

This document does not deal with pressure hazards in steam-heated drying cylinders and does not apply to equipment under pressure.

This document does not apply to machines which are intended for use in explosive atmospheres.

This document does not apply to wetlaid-nonwoven machines which have been manufactured before the date of publication of this document.

2 Normative references

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

ISO 4413:2010, *Hydraulic fluid power — General rules and safety requirements for systems and their components*

ISO 4414:2010, *Pneumatic fluid power — General rules and safety requirements for systems and their components*

ISO 9902-1:2001, *Textile machinery — Noise test code — Part 1: Common requirements*

ISO 9902-3:2001, *Textile machinery — Noise test code — Part 3: Nonwoven machinery*

ISO 10218-1:2011, *Robots and robotic devices — Safety requirements for industrial robots — Part 1: Robots*

ISO 11111-3:2005/Amd.2:2016, *Textile machinery — Safety requirements — Part 3: Nonwoven machinery — Amendment 2*

ISO 11111-7:2005, *Textile machinery — Safety requirements — Part 7: Dyeing and finishing machinery*

ISO 11161:2007, *Safety of machinery — Integrated manufacturing systems — Basic requirements*

ISO/TR 11688-1:1995, *Acoustics — Recommended practice for the design of low-noise machinery and equipment — Part 1: Planning*

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

ISO 13732-1:2006, *Ergonomics of the thermal environment — Methods for the assessment of human responses to contact with surfaces — Part 1: Hot surfaces*

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

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

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

ISO 13851:2019, *Safety of machinery — Two-hand control devices — Principles for design and selection*

ISO 13855:2010, *Safety of machinery — Positioning of safeguards with respect to the approach speeds of parts of the human body*

ISO 13856-1:2013, *Safety of machinery — Pressure-sensitive protective devices — Part 1: General principles for design and testing of pressure-sensitive mats and pressure-sensitive floors*

ISO 13856-2:2013, *Safety of machinery — Pressure-sensitive protective devices — Part 2: General principles for design and testing of pressure-sensitive edges and pressure-sensitive bars*

ISO 13856-3:2013, *Safety of machinery — Pressure-sensitive protective devices — Part 3: General principles for design and testing of pressure-sensitive bumpers, plates, wires and similar devices*

ISO 13857:2019, *Safety of machinery — Safety distances to prevent hazard zones being reached by upper and lower limbs*

ISO 14118:2017, *Safety of machinery — Prevention of unexpected start-up*

ISO 14119:2013, *Safety of machinery — Interlocking devices associated with guards — Principles for design and selection*

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

ISO 14122-3:2016, *Safety of machinery — Permanent means of access to machinery — Part 3: Stairs, stepladders and guard-rails*

ISO 14122-4:2016, *Safety of machinery — Permanent means of access to machinery — Part 4: Fixed ladders*

ISO 14123-1:2015, *Safety of machinery — Reduction of risks to health resulting from hazardous substances emitted by machinery — Part 1: Principles and specifications for machinery manufacturers*

ISO 19353:2019, *Safety of machinery — Fire prevention and fire protection*

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

IEC 60204-11:2018, *Safety of machinery — Electrical equipment of machines — Part 11: Requirements for HV equipment for voltages above 1 000 V a.c. or 1 500 V d.c. and not exceeding 36 kV*

IEC 60447:2004, *Basic and safety principles for man-machine interface, marking and identification — Actuating principles*

IEC 60825-1:2014, *Safety of laser products — Part 1: Equipment classification and requirements*

IEC 61000-6-2:2016, *Electromagnetic compatibility (EMC) — Part 6-2: Generic standards — Immunity standard for industrial environments*

IEC 61310-1:2007, *Safety of machinery — Indication, marking and actuation — Part 1: Requirements for visual, acoustic and tactile signals*

IEC 61496-1:2020, *Safety of machinery — Electro-sensitive protective equipment — Part 1: General requirements and tests*

IEC 61496-2:2020, *Safety of machinery — Electro-sensitive protective equipment — Part 2: Particular requirements for equipment using active opto-electronic protective devices (AOPDs)*

IEC 61496-3:2018, *Safety of machinery — Electro-sensitive protective equipment — Part 3: Particular requirements for Active Opto-electronic Protective Devices responsive to Diffuse Reflection (AOPDDR)*

IEC 61800-1:2021, *Adjustable speed electrical power drive systems — Part 1: General requirements — Rating specifications for low voltage adjustable speed DC power drive systems*

IEC 61800-2:2021, *Adjustable speed electrical power drive systems — Part 2: General requirements — Rating specifications for low voltage adjustable speed AC power drive systems*

IEC 61800-3:2017, *Adjustable speed electrical power drive systems — Part 3: EMC requirements and specific test methods*

IEC 61800-5-1:2016, *Adjustable speed electrical power drive systems — Part 5-1: Safety requirements — Electrical, thermal and energy*

IEC 61800-5-2:2016, *Adjustable speed electrical power drive systems — Part 5-2: Safety requirements — Functional*

IEC 62061:2021, *Safety of machinery — Functional safety of safety-related electrical, electronic and programmable electronic control systems*

EN 349:1993+A1:2008, *Safety of machinery — Minimum gaps to avoid crushing of parts of the human body*

EN 614-1:2006+A1:2009, *Safety of machinery — Ergonomic design principles — Part 1: Terminology and general principles*

EN 614-2:2000+A1:2008, *Safety of machinery — Ergonomic design principles — Part 2: Interactions between the design of machinery and work tasks*

EN 746-1:1997+A1:2009, *Industrial thermoprocessing equipment — Part 1: Common safety requirements for industrial thermoprocessing equipment*

EN 746-2:2010, *Industrial thermoprocessing equipment — Part 2: Safety requirements for combustion and fuel handling systems*

EN 894-1:1997+A1.2008, *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 894-2:1997+A1:2008, *Safety of machinery — Ergonomics requirements for the design of displays and control actuators — Part 2: Displays*

EN 894-3:2000+A1:2008, *Safety of machinery — Ergonomics requirements for the design of displays and control actuators — Part 3: Control actuators*

EN 894-4:2010, *Safety of machinery — Ergonomics requirements for the design of displays and control actuators — Part 4: Location and arrangement of displays and control actuators*

EN 1005-1:2001+A1:2008, *Safety of machinery — Human physical performance — Part 1: Terms and definitions*

EN 1005-2:2003+A1:2008, *Safety of machinery — Human physical performance — Part 2: Manual handling of machinery and component parts of machinery*

EN 1005-3:2002+A1:2008, *Safety of machinery — Human physical performance — Part 3: Recommended force limits for machinery operation*

EN 1005-4:2005+A1:2008, *Safety of machinery — Human physical performance — Part 4: Evaluation of working postures and movements in relation to machinery*

EN 1837:2020, *Safety of machinery — Integral lighting of machines*

EN 12198-1:2000+A1:2008, *Safety of machinery — Assessment and reduction of risks arising from radiation emitted by machinery — Part 1: General principles*

EN 12198-3:2002+A1:2008, *Safety of machinery — Assessment and reduction of risks arising from radiation emitted by machinery — Part 3: Reduction of radiation by attenuation or screening*

3 Terms and definitions

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

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
approach flow system
assembly group consisting of pumps, vats and pipelines, constantly feeding the fibre suspension to the *headbox* (3.2)

3.2
headbox
unit that keeps the fibres dispersed and delivers the stock uniformly onto the wire

Note 1 to entry: There are many types of headboxes, including an open flow box or hydraulic flow boxes.

3.3
former
unit where the fibre suspension is dewatered and in which the web is formed

3.4
hydroentangling unit
unit where the material is bonded with high-pressure water jets

3.5
through-air dryer
unit where the material is dried with hot air

3.6
finishing
unit for applying binders, pigments, colours or fillers onto web

3.7
quality control system
QCS
set of measuring devices consisting of an ionizing and/or non-ionizing radiation source to gauge weight moisture content and other characteristics of the web

3.8
winder
reel-up section where the web is wound onto a reel spool

3.9
jet head
unit that creates high-pressure water jets

3.10
performance level
PL
discrete level used to specify the ability of safety-related parts of control systems to perform a safety function under foreseeable conditions

Note 1 to entry: See ISO 13849-1:2015, 4.5.1.

[SOURCE: ISO 13849-1:2015, 3.1.23]

3.11
safety integrity level
SIL
discrete level (one out of a possible four), corresponding to a range of safety integrity values, where safety integrity level 4 has the highest level of safety integrity and safety integrity level 1 has the lowest

[SOURCE: IEC 61508-4:2010, 3.5.8]

3.12
sensitive protective equipment
SPE
equipment for detecting persons or parts of persons which generates an appropriate signal to the control system to reduce risk to the persons detected

Note 1 to entry: The signal can be generated when a person or part of a person goes beyond a predetermined limit — for example, enters a hazard zone — (tripping) or when a person is detected in a predetermined zone (presence sensing), or in both cases.

[SOURCE: ISO 12100:2010, 3.28.5]

3.13
active opto-electronic protective device
AOPD
device whose sensing function is performed by optoelectronic emitting and receiving elements detecting the interruption of optical radiation, generated within the device, by an opaque object present in the specified detection zone

Note 1 to entry: IEC 61496 gives detailed provisions.

[SOURCE: ISO 12100:2010, 3.28.6]

4 List of significant hazards

Table 1 contains all significant hazards, hazardous situations and hazard events, as far as they are dealt with in this document, which are identified by risk assessment as significant for this type of machinery and which require action to eliminate or reduce the risk.

Table 1 — List of significant hazards

No.	Hazard		Relevant subclause in this document
	Origin (source)	Potential consequences	
Mechanical hazards			
1	Inadequate design of workplaces, means of access, walkways, passageways	Slipping, tripping and falling	5.5; 5.5.9; 5.16; 5.19; 5.37
2	Obstacles in the area of workplaces, means of access, walkways, passageways	Impact hazards for the head	5.5.9; 5.13; 5.18; 6.6
3	In-running nips on rotating rolls, reels, cylinders; Wrapping points of fabrics, wires, ropes, power transmissions elements	Drawing-in or trapping, amputation, death	5.7; 5.8; 5.10; 5.19; 5.29; 5.30.1; 5.30.2; 5.36.1; 5.37; 6.1; 8.2
4	Linear and swivelling movements of machinery parts	Crushing injuries Shearing injuries	5.8; 5.16; 5.17; 5.19; 5.21; 5.31; 5.33; 5.37; 6.1; 6.2; 6.5
5	Knives, edges of wires, sharp edges of machinery frame	Cutting injuries	5.1; 5.33; 5.37
6	Movement of crane, reels	Impact, crushing injuries	5.7; 5.16; 5.18; 5.30.1
7	Rotating bolts on rolls and cylinders	Impact injuries, winding	5.30.1
8	Hydraulic and pneumatic equipment	Injuries by ejection of high-pressure fluids	5.14; 5.15; 5.19; 5.33
9	Ejection and falling of machinery parts	Crushing, impact of persons	5.10; 5.31; 5.37; 6.1
Electrical hazards			
10	Electrical equipment	Electric shock	5.10; 5.12; 5.13; 5.22
11	Electrical equipment	Outside effects on electrical equipment	5.10; 5.13
Thermal hazards			
12	Hot surfaces of machinery parts	Burning and scalds by contact of persons	5.21; 5.28
Noise hazards			
13	Machine and machine components	Hearing loss and physiological disorders (as occupational diseases) and interference with oral communication and acoustic warning signals (as source of accidents)	5.20; 6.3
Radiation hazards			
14	Measuring unit with radioactive source	Ionising radiation, cancer causing	5.27; 6.5
15	Infrared dryer	Irritating or burning to the skin by infrared radiation	5.21
16	Laser	Burning, radiation	5.26; 5.27
Hazards generated by material and substances			
17	Chemical substances	Loss of health, injuries of the skin or eyes	5.25
18	Nonwoven, dryer, hydraulic oil	Fire	5.13; 5.21; 5.22; 5.28
Hazards generated by neglecting ergonomic principles			
19	Neglect of ergonomic principles, inadequate lighting of the workplace	Discomfort, fatigue, stress, overload, blinding, falling	5.5.6; 5.13; 5.19; 5.24; 5.28; 5.37

Table 1 *(continued)*

No.	Hazard		Relevant subclause in this document
	Origin (source)	Potential consequences	
Hazards caused by failure of energy supply, control system and other functional disorders			
20	Unexpected start-up	Crushing, shearing, impact, drawing-in or trapping	5.7; 5.9; 5.11; 5.13; 5.14; 5.15; 5.35
21	Malfunction in the control system	Crushing, shearing, impact, drawing-in or trapping, overturn, falling or ejection of objects	5.8; 5.9; 5.10; 5.12; 5.13; 5.16; 5.19; 5.29; 5.30.1; 5.33; 5.36.1; 6.1; 6.5
Combination of hazards			
22	Work in confined spaces	Asphyxiate, inhalation of chemical substances, crushing, shearing, impact, electric shock, stress	5.32; 5.35

5 General safety requirements and/or protective/risk reduction measures

5.1 General

This subclause contains safety requirements and/or protective/risk reduction measures to be taken in relation to significant hazards related to wetlaid-nonwoven machinery. Machinery shall comply with the general and specific safety requirements and/or protective/risk reduction measures of this document.

Where the means of reducing the risk is by the arrangement of the installed machine or a safe system of working the machine, the manufacturer shall give a detailed description of this in the instructions handbook.

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

5.2 Safety requirements for the different "phases of life" of wetlaid-nonwoven machines

The safety requirements given in Clauses 5 and 6 apply to the use and maintenance of the machine/machine sections. For other phases in the life of a machine, see Clause 8.

5.3 Safety requirements for design/risk minimization

A design concept for the machine and/or its mechanisms which does not inherently create a hazard by wetlaid-nonwoven machines shall, as far as possible, be adopted.

The technical guidelines on inherently safe design in accordance with ISO 12100:2010, 6.2, shall apply.

For risk minimization on wetlaid-nonwoven machines, the "strategy for risk assessment and risk reduction" cited in ISO 12100:2010, Clause 4, shall apply.

The target of risk reduction can be achieved by an elimination of hazards or by separate or simultaneous reduction of each of the two elements determining the risk involved:

— probability of occurrence of harm;

— the severity of that harm.

The "three-step procedure" described in ISO 12100:2010, 6.1, shall always be observed:

— Step 1: Inherently safe design measures;

— Step 2: Safeguarding and/or complementary protective measures;

— Step 3: Information for use.

Guards and safety devices used to reduce risks from wetlaid-nonwoven machines shall conform to the requirements of the standards given in Tables 2 and 3.

Table 2 — Safety requirements and/or protective/risk reduction measures for guards

Application	Reference
Guard selection, unless specified in Clause 6	ISO 14120:2015, Clause 6
Guard design and construction	ISO 14120:2015, Clause 5
Guard fastening	ISO 14120:2015
Guard arrangement, unless specified in Clause 6	ISO 13857:2019, Tables 1, 4, 7 and B.1
Guard interlocking, unless specified in Clause 6	ISO 14119:2013, Clauses 5, 6 and 7
Fence guards	See Clauses 6 and A.2

Table 3 — Safety requirements and/or protective/risk reduction measures for safety devices

Application	Reference
Guard selection, unless specified in Clause 6	ISO 12100:2010, 6.3.2
Technical characteristics of safety devices	IEC 61496-1:2020
Positioning of safety devices, unless specified in Clause 6	ISO 13855:2010
Interlocking (with and without guard locking): — selection — design	ISO 14119:2013, Clauses 5, 6 and 7 IEC 61496-1:2020
Electro-sensitive protective equipment[a]: — arrangement	IEC 61496-1:2020 ISO 13855:2010
AOPDs[a]: — arrangement — safety distance (upper and lower limbs)	IEC 61496-2:2020 ISO 13855:2010 ISO 13857:2019
AOPDs responsive to diffuse reflection (AOPDDR):[a] — arrangement — safety distance (upper and lower limbs)	IEC 61496-3:2018 ISO 13855:2010 ISO 13857:2019
Pressure-sensitive mats and floors	ISO 13856-1:2013
Pressure-sensitive edges and bars	ISO 13856-2:2013
Pressure-sensitive bumpers, plates, wires	ISO 13856-3:2013
Two-hand controls: — selection[b] — arrangement	IEC 60204-1:2016, 9.2.3.8 ISO 13851:2019 ISO 13855:2010
Hold-to-run control devices (touch control, biased-off switch)	IEC 60204-1:2016, 9.2.3.7

[a] The type selected in accordance with IEC 61496-1:2020 shall be consistent with the required PL or SIL of the safety-related part of the control system, as defined in ISO 13849-1:2015, 4.2.2 (or IEC 62061:2021, 5.2.4).

[b] The type selected in accordance with ISO 13851:2019 shall be consistent with the required PL or SIL of the safety-related part of the control system, as defined in ISO 13849-1:2015, 4.2.2 (or IEC 62061:2021, 5.2.4).

5.4 Safety requirements for fitting of parts

Measures shall be provided to prevent a part from being fitted incorrectly (e.g. using shape or configuration to physically prevent incorrect installation). When this is technically not possible, the parts shall be clearly marked.

5.5 Workplaces, means of access, walkways, passageways/access to elevated operating positions and servicing points

5.5.1 For operating, make-ready, troubleshooting as well as maintenance operations, work platforms including their access stairs and passageways shall be provided, if necessary. Work platforms shall have adequate slip resistance and stability, protection against persons falling off as well as protection against mechanical and chemical effects including hazards from corrosion in the wet section. Platforms shall be designed for a surface load of at least 5 000 N/m^2.

5.5.2 Access to stationary work platforms shall be selected and designed according to the specification given in Table 4. The normal type of access to be provided is type 1. Type 1 access has pitch angles of between 30° and 45°.

Table 4 — Specifications for access to stationary work platforms

	Access		
	Type 1 (normal case)	**Type 2 (exception)**	**Type 3 (exception)**
Designation	Stairs	Machine ladder	Stepladder
Pitch angle	30° to 45°	> 45° ≤ 70°	70° to 90°
Width[a]	≥ 0,60 m	0,50 m to 0,80 m	0,60 m
Height	≤ 4,00 m	≤ 4,00 m	≤ 6,00 m
Height of railings[b]	0,90 m to 1,10 m	0,90 m	—
Type of treads	Steps	Steps	Steps, flat treads
Additional requirements according to:	ISO 14122-3:2016	ISO 14122-3:2016	ISO 14122-4:2016

[a] The width is measured between handrails.

[b] The height is measured on the front edge of the step.

Where type 1 access cannot be used for production reasons, type 2 access shall be used or, where type 2 is also not possible for technical reasons, type 3 access can be selected. Technical reasons can, for example, exist where:

a) access stairs would unduly restrict the passage;

b) a connection is required between two adjacent workplaces of different heights;

c) stairs would impede access to the machine for trouble shooting.

For safe threading on any kind of access facility, steps are required to have a uniform height and depth, including the first and the last step.

The maximum height of type 1 and type 2 access stairs shall be 4,00 m. Higher stairs shall be provided with an intermediate platform.

5.5.3 Type 2 access stairs described in 5.5.2 can have a pitch angle in the range of 45° to 70°. Pitch angles in excess of 60° should be avoided. Type 2 stairs with a height of more than 1,00 m shall be provided with two handrails for fall-off protection. The height of the handrail shall be 0,90 m above the

front edge of the tread. Intermediate rails are to be provided where the clearance below the handrail is more than 0,50 m (see Figure 1).

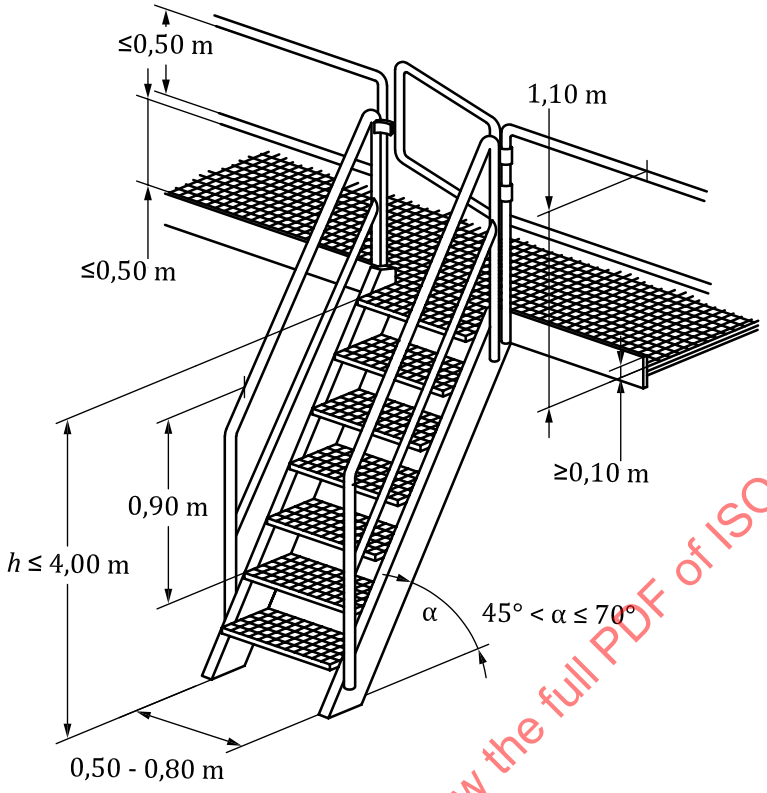


Figure 1 — Access stairs type 2

5.5.4 Platform surfaces shall be slip-resistant and avoid tripping hazards.

5.5.5 Covers on floor openings shall be capable of supporting possible traffic loads and shall be laid flush with the floor surface. It shall not be possible to unintentionally change the position of the cover. Also, buckling or bending of the cover shall not cause projecting edges.

5.5.6 Stationary platforms shall have a width of at least 0,60 m. Where there is danger of falling into the machine from machine floors, platforms or access stairs, the machine frame can act as a safeguard against falling if:

— it meets the requirements specified for railings;

— the distance between platform and machine frame is at least 0,12 m.

Machine protrusions are not allowed to reduce the area available for walking to less than 0,40 m. Any machine parts causing obstructions shall be provided with paddings where possible, and with warnings wherever practicable.

5.5.7 Workplaces with a falling height of more than 1,00 m shall be equipped with railings of a minimum height of 1,10 m on the open side(s).

In deviation, the height of safeguarding facilities against falling off can be less than 1,10 m where space available is restricted for operational reasons. In such cases, additional measures for fall-off protection shall be taken such as the provision of cranked rails.

Railings shall be provided with a toe board designed in such a way as to prevent any person from slipping underneath the handrail. This can be achieved by fitting an intermediate rail with a maximum

distance of 0,50 m between handrail and intermediate rail or between intermediate rail and toe board. The maximum distance between the outer railing elements and the adjacent fall-off protection elements such as individual railing elements, walls, frames, handrails on stairs shall not exceed 0,12 m.

On working platforms with a falling height in the range of 0,60 m to 1,00 m, handrails shall be provided wherever possible without impeding production or operational procedures.

5.5.8 Railings interrupted due to access to the work platform, and walkways having a falling height of more than 2,00 m, shall be safeguarded against persons falling off. Danger of falling exists where access is via access stairs type 2 or type 3 according to 5.5.2. The risk of falling is considerably reduced where an intermediate platform is provided between access stairs and platform or walkway, or where access is from the narrow end of a walkway. Safeguarding interrupted railings can be effected, for example, by automatically closing doors which open only in the direction of the work platforms or walkway. Chains are no suitable means of safeguarding against persons falling off.

5.5.9 Stationary working platforms and their access stairs, walkways and passageways shall have a clearance height of 2,00 m minimum. Where this height cannot be used for constructional reasons, the risk of injury shall be reduced by paddings and danger warning.

5.5.10 Removable guards with interlocks shall be used if the frequency of access can be expected to be high, e.g. more often than once a month. Interlocking and guard locking devices shall conform to ISO 14119:2013. The interlocking shall comply with at least PL = c in accordance with ISO 13849-1:2015 or SIL = 1 in accordance with IEC 62061:2021.

5.6 Measures for the escape and rescue of trapped persons

There is a possibility of:

— more severe injury due to delay in rescue;

— causing additional injury to the trapped person during the rescue;

— injury to rescuer when securing release.

The following measures shall be provided for the escape and rescue of trapped persons:

— escape routes in wetlaid-nonwoven machinery according to Clause C.1 generating operator-trapping hazards,

— fence guard or enclosure shall be in accordance with Clause A.2.

Information shall be included in the instructions handbook on the precise method of rescue to be followed (e.g. the use of specially provided equipment such as easily removable bearings, means to reverse the normal working direction, means to move components apart, pressure-release devices or hand-operated valves for hydraulic or pneumatic systems).

5.7 Start-up warning device

On machines where there is no clear view of all work positions or where mutual communication is difficult, a start-up warning device shall be provided. For machinery that consists of several sections and where viewing and communication is difficult, a warning signal shall be issued before the start-up of each section to allow persons in danger to reach a safeguarded place within sufficient time. The start-up warning shall be made by an audible signal which can be supported by a visual signal (see ISO 7731:2003).

A sufficient number of warning devices shall be provided to make sure that every person within or close to the machine can be reached by the warning signal.

If a start-up warning device is needed, the control system shall comply with PL = c in accordance with ISO 13849-1:2015 or SIL = 1 in accordance with IEC 62061:2021. The start-up warning device shall be coupled to the control element for starting the machine in such a way that between start of the warning signal and start-up of the machine there is sufficient time for persons to retreat to a safe area. Readiness of the machine to be started begins after elapse of the signal and the waiting time and ends after elapse of the release time. The waiting time is counted from the end of the signal. Start-up warnings are according to Table 5.

Table 5 — Start-up warnings

Signal time s	Waiting time s	Release time s
5	15	≤ 30

The warning signal for starting (= acoustic signal) shall sound for 5 s. After a waiting period of 15 s, the machine/plant can be put into operation within the following 30 s. After this time, readiness for operation is revoked.

The timer function of the start-up warning sequence and the interlocking with the start-up function shall comply with at least PL = c in accordance with ISO 13849-1:2015 or SIL = 1 in accordance with IEC 62061:2021.

Warning devices shall be listed in the operating instructions in order to inform about residual hazards as specified in ISO 12100:2010, 6.4.3 and 6.4.4. Safety signs shall be in accordance IEC 61310-1:2007.

The instructions handbook shall describe the start-up warning process.

5.8 Emergency stop device and braking system

An emergency stop device shall be provided. The device shall satisfy the requirements of ISO 13850:2015 and IEC 60204-1:2016. It shall act on all hazardous movements of the machine.

The emergency stop function shall act on all hazards of the entire machine including the machine pulper and measuring device. Steam and condensate system and burners shall be included in the emergency stop function. The emergency stop system shall act on the whole machine.

The emergency stop function shall be available and operational at all times, regardless of the operating mode. Emergency stop devices shall be a back-up to other safeguarding measures and not a substitute for them.

The emergency stop control system of the sectional drives shall comply with at least PL = c in accordance with ISO 13849-1:2015 or SIL = 1 in accordance with IEC 62061:2021.

When a brake is required to achieve a suitable stopping time, it shall operate on the actuation of the emergency stop device, e.g. mechanical or electro-dynamic brakes. Braking devices shall operate in such a way that the stopping time following actuation of the emergency stop is as short as possible without causing additional hazards. The requirement “as short as possible” implies that the stopping time normally is less than the shortest possible start-up time.

On electrical braking systems, the emergency stop function shall comply with stop category 1 in accordance with IEC 60204-1:2016. Emergency stop principles shall be made in accordance with IEC 60204-1:2016, 9.2.3.4. Where the stop is ensured by a timer function, it shall act as the second channel to ensure the removal of the power.

Emergency stop devices shall be sited within easy reach of the operator and shall be with a maximum distance of 15 m from any point on the machine. Emergency stop devices shall also be located:

a) at every operator station;

b) alongside the operating and drive sides;

c) in machine pits;

d) in all areas where access is required, e.g. for removing broke.

5.9 Isolation and energy dissipation, prevention of unexpected start-up

For maintenance and inspection, adequate means shall be provided for isolation and dissipation of energy. They shall satisfy the requirements of ISO 14118:2017, IEC 60204-1:2016, 5.3, ISO 4413:2010 and ISO 4414:2010.

Actuating devices for energy isolation shall be capable of being locked in the "isolated" position. Locking devices shall be designed such as to allow, where required, the provision of multiple padlock or key systems in accordance with ISO 14118:2017, 5.3.

Means for energy isolation and dissipation are listed in Table 6, classified according to type of energy.

Table 6 — Means for energy isolation and dissipation

Type of energy	Energy isolation	Energy dissipation
Electric current with voltage ≤ 1 kV	Supply disconnecting device according to IEC 60204-1:2016, 5.3	Resistors for capacitators or other means according to IEC 60204-1:2016, 6.2.4
Electrical current with voltage > 1 kV	Power supply switch disconnector with isolating properties, load disconnector, disconnector with interlocking to prevent switching in the current-carrying condition	Means for earthing and short-circuiting
Mechanical position energy (gravity)	—	Latch, support, safety catch
Hydraulic system	Supply disconnecting device according to IEC 60204-1:2016, 5.3 for electrical supply; valve according to ISO 4413:2010	Means according to ISO 4413:2010
Pneumatic system	Shutoff valve according to ISO 4414:2010, 5.2.8	Relief valve according to ISO 4414:2010
Steam	Valve and isolating device	Drain pipe with valve

Supply disconnecting devices for electrical energy with voltages up to 1 kV are described in IEC 60204-1:2016.

For voltages above 1 kV, switches shall be used which provide an all-pole disconnection from the supply. Switching contact clearances shall be appropriate to ensure isolating for specific voltages. Switching/disconnecting devices shall be designed such that the risk of interference arcs is minimized. Means shall be provided for isolation control and for earthing and short-circuiting, and shall be described in the instructions handbook.

Plug-and-socket systems for isolating electrical energy in accordance with ISO 14118:2017, 5.2.2, are not permissible for wetlaid-nonwoven machines and equipment.

Machines shall be provided with devices for safeguarding against erroneous and unauthorized start-up of the drives of the individual machine groups in accordance with ISO 14118:2017 and IEC 60204-1:2016, 5.4.

This requirement is fulfilled, for example, on:

a) constant drives, by locking the all-pole main switch in the OFF position;

b) static converter direct-current group drives, by locking a safety switch installed in the control line of the three-phase contactor and feedback of the OFF status of the three-phase contactor;

c) DC/AC converter three-phase drives with variable frequencies, by locking a safety switch installed in the control circuit of the converter which prevents energy flow to the AC drive in the OFF position and feedback of safe status. Fault analysis can take into account the fact that asynchronous machines require a rotating field for start-up.

The safety stop with prevention against unexpected start-up shall be indicated on the control panel, e.g. with a display "drive safe" or with a signal lamp "on".

The part of the control system which gives the feedback of "drive safe" (e.g. main contactor, DC/AC-converter), shall comply with at least PL = c in accordance with ISO 13849-1:2015 or SIL = 1 in accordance with IEC 62061:2021.

For prevention of unexpected start-up following return of power after disruption of supply voltage, the requirements of IEC 60204-1:2016, 7.5, shall be satisfied.

In order to prevent that stopped part of the machinery drift away from the stopping position without action of the control devices, brakes, self-arresting gears or automatic retaining pawls shall be used.

With pneumatically or hydraulically operated devices, manually operated devices for energy disconnection shall be provided in the vicinity so that the actuating element of the movement can be de-activated.

The instructions handbook shall describe the devices for isolation, energy dissipation and prevention of unexpected start-up and their use for maintenance and repair operations with operator intervention. IEC 60204-1:2016, 5.4, shall be complied with.

5.10 Electric drive system and power transmission elements

Electric drive systems and related power transmission elements shall be designed so that risks from mechanical and electrical hazards are avoided or reduced.

For adjustable speed electrical power drive systems, IEC 61800-1:2021, IEC 61800-2:2021, IEC 61800-5-1:2016 and IEC 61800-5-2:2016 shall be applied.

For electromagnetic compatibility, IEC 61000-6-2:2016 and IEC 61800-3:2017 shall be applied.

The electric drive system shall be designed so that the speed does not exceed the design speed. The related control system shall comply with at least PL = c in accordance with ISO 13849-1:2015 or SIL = 1 in accordance with IEC 62061:2021.

The electric drive system shall be designed so that, in crawl speed mode, the speed does not exceed the maximum crawl speed 15 m/min. The related control system shall comply with at least PL = c in accordance with ISO 13849-1:2015 or SIL = 1 in accordance with IEC 62061:2021.

Transmission elements between the drives and respective machine sections shall be safeguarded by guards.

5.11 Specific safety requirements for starting and stopping

Hazards arising from starting and stopping shall be reduced by the application of safety requirements selected from the sections of IEC 60204-1:2016 or from other relevant standards in accordance with Table 7.

Table 7 — Safety requirements for starting and stopping

Application	Reference
Start-up	This document
Stopping[a]	IEC 60204-1:2016, 9.2.2
Unexpected start-up	ISO 14118:2017
Isolation from energy sources	IEC 60204-1:2016, Clause 5
Start-up by inadvertent actuation	This document
Start-up by unauthorized persons	This document
Automatic restart after process interruption	This document
Start-up after interruption of power supply	IEC 60204-1:2016, 7.5
Emergency stopping	This document ISO 12100:2010, 6.3.5.2 ISO 13850:2015 IEC 60204-1:2016, 10.7 and 10.8 ISO 11161:2007
[a] Each workstation of the machine shall be provided with a control device for generating a safe normal stop in accordance with IEC 60204-1:2016; stop category 0 or 1.	

a) Requirements concerning start-up by inadvertent actuation shall be satisfied by any of the following:

   1) control switch button slightly recessed in relation to the surrounding surface;

   2) covered control switch;

   3) control switch requiring at least two separate dissimilar operations (e.g. pressing and turning);

   4) control switch located beneath a hinged flap;

   5) control switch with lock in the off position;

   6) two-button start control;

   7) operation via monitor with double query.

b) Wetlaid-nonwoven machines, installation or systems which cannot be totally observed from the main control position, or in the proximity of which communication is difficult shall, in addition to the measures specified in ISO 12100:2010, 6.2.11.10, be provided with individual key-operated control switches or similar devices (e.g. lockable isolator switches) to prevent the equipment being started up by unauthorized persons. In order to observe the danger zones from the control position, mirrors, camera screens, a raised control position or a combination of these shall be provided to achieve adequate visibility.

   NOTE 1 "Start-up by unauthorized persons" means switching on a machine by a person neither deputed nor directed to do so.

   NOTE 2 For interconnected machines (integrated manufacturing systems), the safety requirements given in ISO 11161:2007 can be used.

c) Where a warning signal is used to warn against the start of a machine and to allow persons in danger to reach a safeguarded place within sufficient time, the start/restart shall be in accordance with ISO 11161:2007, unless otherwise indicated in this document.

5.12 Control system and actuators

Electrical control systems shall comply with IEC 60204-1:2016, hydraulic control systems shall comply with ISO 4413:2010 and pneumatic control systems shall comply with ISO 4414:2010.

Hazards arising from the control system shall be reduced by the application of safety requirements selected from the sections of IEC 60204-1:2016 and other relevant standards in accordance with Table 8.

Control devices shall be designed and marked in such way that they are clearly visible and identifiable, using pictograms where appropriate, e.g. using marking in accordance with IEC 60204-1:2016, 10.2.2.

Control systems shall be subject to fault-analysis and shall comply with the requirements of ISO 13849-1:2015 or IEC 62061:2021. Where safety-related failures cannot be excluded, measures shall be taken in order to prevent failures generating a hazardous malfunctioning of the machine. Such measures are, for example:

a) mechanical safety measures;

b) redundancy in the control systems;

c) fault-detecting circuits.

As a minimum, interlocking devices on guards and their safety-related control systems shall comply with PL = c in accordance with ISO 13849-1:2015 or SIL = 1 in accordance with IEC 62061:2021.

NOTE 1 This is compatible with operations that are of low frequency with low exposure and/or of low risk of harm, e.g. removal of broke material.

Specific safety requirements for certain safety-related parts of control systems and devices shall be in accordance with Table 8.

Table 8 — Safety requirements for control systems

Application	Reference
Design of control system	ISO 12100:2010, 6.2.11
Control circuits and functions	IEC 60204-1:2016, Clause 9
Control interfaces	IEC 60204-1:2016, Clause 10
Programmable electronic equipment	ISO 13849-1:2015 or IEC 62061:2021
Control gear	IEC 60204-1:2016, Clause 11
Fault exclusion/proven components	ISO 13849-2:2012, Clause 7
Required PL or SIL	ISO 13849-1:2015 or IEC 62061:2021
Categories of resistance to faults	ISO 13849-1:2015, Clause 6
Control devices	IEC 60204-1:2016, Clause 10
Safety signals, symbols and signs (visual, acoustic and tactile)	IEC 61310-1:2007, Clauses 4 and 5
Arrangement of control devices	ISO 12100:2010, 6.2.8 and 6.2.11.8
Actuating principles	IEC 60447:2004

NOTE 2 If, in this document, a PL in accordance with ISO 13849-1:2015 or an SIL in accordance with IEC 62061:2021 has not been identified or a lower level of integrity is considered appropriate, a risk assessment carried out by the manufacturer can be used to determine or confirm a suitable PL or SIL. Such a PL or an SIL is the responsibility of the manufacturer and outside the scope of this document.

Table 9 contains a summarized list of safety functions, PLs and SILs specified in this document.

The validation of safety functions shall be made in accordance with ISO 13849-2:2012.

Table 9 — List of safety functions, PLs and SILs specified in this document

Safety function	Subclause in this document	Performance levels (at least)	Safety integrity levels (at least)
Interlocking of guards	5.5.10, 5.12, 5.16, 5.19, 5.30.1, 5.33	PL c	SIL 1
Start-up warning (interlocking function)	5.7	PL c	SIL 1
Emergency stop of sectional drives	5.8	PL c	SIL 1
Emergency stop of linear or swivelling moved parts	5.8	PL c	SIL 1
Isolation and energy dissipation, prevention of unexpected start-up	5.9	PL c	SIL 1
Limitation of maximum speed	5.10	PL c	SIL 1
Limitation of crawl speed (conditions, see 5.10)	5.10	PL c	SIL 1
Control system and actuators	5.12	PL c	SIL 1
Control systems and actuators of particularly dangerous machine elements/drawing in zone/cutting devices	5.29, 5.30.1, 5.33	PL c	SIL 1
Jogging mode for crawl mode	5.19	PL c	SIL 1
Manual web threading	5.36.2	PL c	SIL 1
Control systems and actuators — headbox/former + jet head/hydroentangling unit/dryer	6.1, 6.2, 6.4	PL c	SIL 1
Safeguarding of lifting gates on the hood	6.3	PL c	SIL 1
Safety function of safety devices on measuring units	6.5	PL c	SIL 1
Interlocking of safety on in-running nips of the reel up	6.6	PL d	SIL 2

5.13 Electrical equipment

Electrical equipment can cause two types of hazards:

— electrical, generated by contact of persons with live parts and parts which have become live under fault conditions (e.g. insulation fault or failure), or by approach of persons to live parts, especially in the high voltage range;

— mechanical, due to failure of electrical equipment, e.g. failure of the control system, unexpected restart.

Electrical equipment of drives, control systems, measuring and control devices, lighting and heating systems shall comply with IEC 60204-1:2016, Clauses 4 to 13 and 16 to 18. For voltages above 1 kV which are not sufficiently covered by IEC 60204-1:2016, the high-voltage equipment and safety measures used shall be in accordance with IEC 60204-11:2018. Where electrical equipment is fitted not in separate operating rooms, but in the vicinity of machines, the generally chosen type of enclosure is IP 54 according to IEC 60529:2013.

NOTE In certain cases, a higher category can be required, e.g. for equipment mounted in machine areas where water jets or compressed air are used for cleaning.

Electrostatic charges of machine parts are to be avoided as far as possible by, for example, equipotential bonding.

The instructions handbook shall contain information on the safety measures to be applied when carrying out inspection work on electrical equipment. This includes instructions relating to operator training and use of personal protective equipment.

For electromagnetic compatibility, IEC 61000-6-2:2016 and IEC 61800-3:2017 shall be applied.

For lamps, cables, ducts and supporting elements carried above working platforms and walkways as well as their means of access, care shall be taken that there is a clear passage.

Hazards arising from electrical equipment shall be reduced by the application of safety requirements selected from the sections of IEC 60204-1:2016 in accordance with Table 10.

Table 10 — Safety requirements for electrical equipment of machines

Electrical hazards	Reference in IEC 60204-1:2016
Electric shock	Clauses 6 and 8
Over-current, over-speed and overload	Clauses 7 and 8
Environmental influences	Clause 4
Restart after voltage drop or supply interruption	Clause 7.5
Accessibility, layout and identification of control equipment	Clauses 10, 11 and 16
Ergonomics for manual operation	Clauses 10 and 11
Cabling and wiring	Clauses 12 and 13
Accessories and lighting	Clause 15
Documentation and instructions handbook	Clause 17
Testing	Clause 18

5.14 Hydraulic equipment

There is a risk generated when fluid under pressure is ejected from or leaks out of tubes, fittings, nozzles, vessels and hoses.

The requirements of ISO 4413:2010 shall be satisfied.

5.15 Pneumatic equipment

There is a risk generated when fluid under pressure is ejected from or leaks out of tubes, fittings, nozzles, vessels and hoses.

The requirements of ISO 4414:2010 shall be satisfied.

5.16 Special operation

5.16.1 General

Special operation, procedures and action not included in normal operation (e.g. make-ready, tuning, major cleaning, elimination of substantial process faults, maintenance such as the removal of broke) frequently result in hazards which deviate from those occurring under normal operation, since such operations can require to be performed with the machine running and the guards not in place and/or the safety devices inoperative.

5.16.2 Specific safety requirements

In order to avoid injuries when changing and transporting pointed or sharp machine parts, adequate safeguarding devices (e.g. special tools described in the instructions handbook) shall be provided by the manufacturer. The use of such devices shall be described in the instructions handbook. Common personal protective equipment (PPE) described in the instructions handbook shall be provided by the user.

NOTE Pointed and sharp machine parts are, for example, doctor blades, cut-off knives, slitting knives and disk knives.

The safety requirements according to Table 11 shall apply.

Table 11 — Safety requirements for special operations

Application	Reference in ISO 12100:2010
Principles relating to manual control	6.2.11.8
Selection of control and operating modes	6.2.11.10

So far as practicable, adjustment, lubrication and maintenance points shall be located outside danger zones, or warning notices shall be fixed and details included in the information for use.

Lubrication points shall be easy to identify and able to be reached and operated without danger. If access is needed, it shall be designed and provided in accordance with 5.5. Where lubrication points cannot be provided outside danger zones, lubrication systems with remote or automatic control shall be used. Where this is not practicable, the instructions handbook shall identify safety measures required when carrying out lubrication work, especially the use of machines according to 5.9.

The machine shall be designed so that adjustments, tuning and elimination of minor process faults can be easily and safely carried out. Wherever possible, maintenance, repair, make-ready, cleaning, servicing operations and dangerous elimination of process faults shall be carried out while machinery is at a standstill and totally isolated from all dangerous sources of motive power.

If this work cannot be carried out with the machinery at standstill, the guards and safety devices shall remain activated. If for technical reasons the safety devices cannot be remain activated, it shall be ensured that all dangerous movements which are not required for this work in the hazardous area are stopped.

A crawl speed according to Table 12 is considered to be a risk reduction measure where access to a danger zone or to a moving machine part is required for adjustments, setting-up or cleaning and inspection, and where such operations cannot be carried out with the machine in standstill, see ISO 12100:2010, 6.2.11.9.

Where, on wetlaid-nonwoven machines, overhead cranes are provided for roll and reel transport, machines shall be designed so that:

a) machine height allows a clearance of at least 0,50 m between the machine and the crane (except load carrying equipment);

b) in the area of machine working platforms and walkways, the passage height specified in 5.5 between such levels and the crane shall be achieved.

Where the requirement given in a) cannot be achieved for constructional reasons, devices shall be provided which prevent persons from being hit by the crane, for example, as follows:

— Movable guards (gates) with an interlocking device in accordance with ISO 14119:2013 shall be provided on the access points to the relevant working platforms or/and walkways. An interface with the crane drive system shall be provided, so that the guards (gates) can be interlocked with crane movements such that crane movement is stopped when the gate is opened and prevented when the gate is open. The interlocking shall comply with at least PL = c in accordance with ISO 13849-1:2015 or SIL = 1 in accordance with IEC 62061:2021. The interface shall be described in the instructions handbook. For the arrangement of the guards (gates) the safety distances given in ISO 13857:2019, Table 2, shall be taken into account. To re-start crane operation, a reset device shall be provided beside the electrically interlocked gates which cannot be reached from any position inside the danger zone.

— Safety devices with approach reaction on both sides of the crane intended to stop the crane movement if a person is present in the detection area of the safety device. Interlocking with sensors on both sides of the crane sufficient to detect persons in the path of the crane and bring the crane to a safe stop before contact is made.

Where the requirements given in a) or b) cannot be achieved for constructional reasons, on each access point to the relevant working platforms or/and walkways a warning sign “Beware of crane — Access prohibited” shall be provided.

Where the requirements given in a) or b) cannot be achieved for constructional reasons at maintenance working positions, additional measures shall be provided, e.g. trip devices on both sides of the crane for stopping the crane movements. These additional measures shall be determined by agreement between the manufacturer and the user.

Reference shall be made in the manufacturer’s instructions handbook to the correct procedures and precautions for special operations, to residual risks and the need for specific training of operators to counter these risks. Reference shall also be made to the fact that special operations may only be carried out by authorized and specially trained personnel.

The instructions handbook shall describe safety measures to be observed during make-ready and maintenance, such as:

— use of devices for stopping, energy isolation, dissipation of stored energy, see 5.9;

— use of lifting equipment and make-ready tools;

— use of personal protection equipment such as gloves, protective shoes;

— use of platforms, scaffolding and stairs;

— training, coordination and qualification of personnel.

5.17 Mobile machines, handling devices, operational parts

5.17.1 General

Machines or sections of machines and handling devices which can move from one location to another automatically, generally along a defined track, or rotate, are often used. Operational parts thereof move under automatic control.

The safety requirements given in Table 8 for control systems and Table 10 for automatic machines and equipment shall apply.

5.17.2 Specific hazards

Mechanical, in particular crushing, shearing and impact between moving machines and fixed parts of adjacent machinery, installations or buildings, etc., between moving handling devices or operational parts and adjacent fixed or moving machine parts, machinery, installations or buildings.

5.17.3 Specific risks

Intentional or unintentional access by exposed persons during automatic operation and access during special operation, leading to a high probability of minor-to-severe injury.

5.17.4 Specific safety requirements

a) The machine or handling device or operational parts shall be designed in accordance with EN 349:1993+A1:2008 to provide minimum gaps to avoid crushing, or the pressure, force or energy caused by the movement of a machine, handling device or operational parts shall not expose a person in its path to harm. Maximum values of force, pressure and energy considered to prevent harm are given in Clause A.3.

b) Where a) cannot be fulfilled, fence guards according to Clause A.2 or other safeguarding shall be provided for moving machines. Fixed or movable enclosing guards or safety devices shall be provided for handling devices and operational parts to prevent access to the danger zones, or those

sides of the machine, handling device or operational parts facing the direction of travel shall be protected by full-face SPE (e.g. trip plates, trip bars, pressure-sensitive edges, AOPD), designed to arrest the movement of the machine or handling device on contact before injury can occur.

When a safety device has operated, restarting of the machine, handling device or operational parts shall only be possible by a deliberate act of the operator. Where the operator cannot view all the danger zones from the start control position, restart may only be possible after the operation of a reset control at position(s) where persons in the related hazard zone can be detected.

Alternatively, operation of a safety device may cause the direction of motion to reverse, if this in itself does not create a new hazard.

c) Where handling devices are reprogrammable, they shall be in accordance with ISO 10218-1:2011, Clause 5.

d) The instructions handbook shall give details of the clearance required around the mobile machine, handling devices or operational parts to prevent crushing and shearing points between the mobile device and fixed parts of the factory or other machines. These clearances shall as a minimum be in accordance with 5.17.4 a).

5.18 Floor-mounted and overhead rails (tracks)

5.18.1 General

Floor-mounted rails and overhead rails are part of wetlaid-nonwoven machines to enable necessary transport tasks.

5.18.2 Specific hazard

There is a specific hazard of tripping over floor-mounted rails and impact from walking into overhead rails/tracks.

5.18.3 Specific risk

With high probability, there is a specific risk of moderate injury when access is needed to those areas beneath, or over, which the rails/tracks are located.

5.18.4 Specific safety requirements

a) Floor-mounted rails shall be recessed in work areas and passageways.

b) The rails/tracks shall have permanent high-visibility markings at all possible impact/tripping points.

5.19 Equipment and measures for cleaning and removal of broke

5.19.1 General

Equipment for safe removal of broke, material waste, material dust and other impurities shall be specified by the manufacturer.

Automatic systems for cleaning and removal of broke shall be provided wherever technically feasible. This includes showers for the cleaning of wires, doctor blades for the cleaning of rolls and cylinders, and suction systems for the removal of material dust.

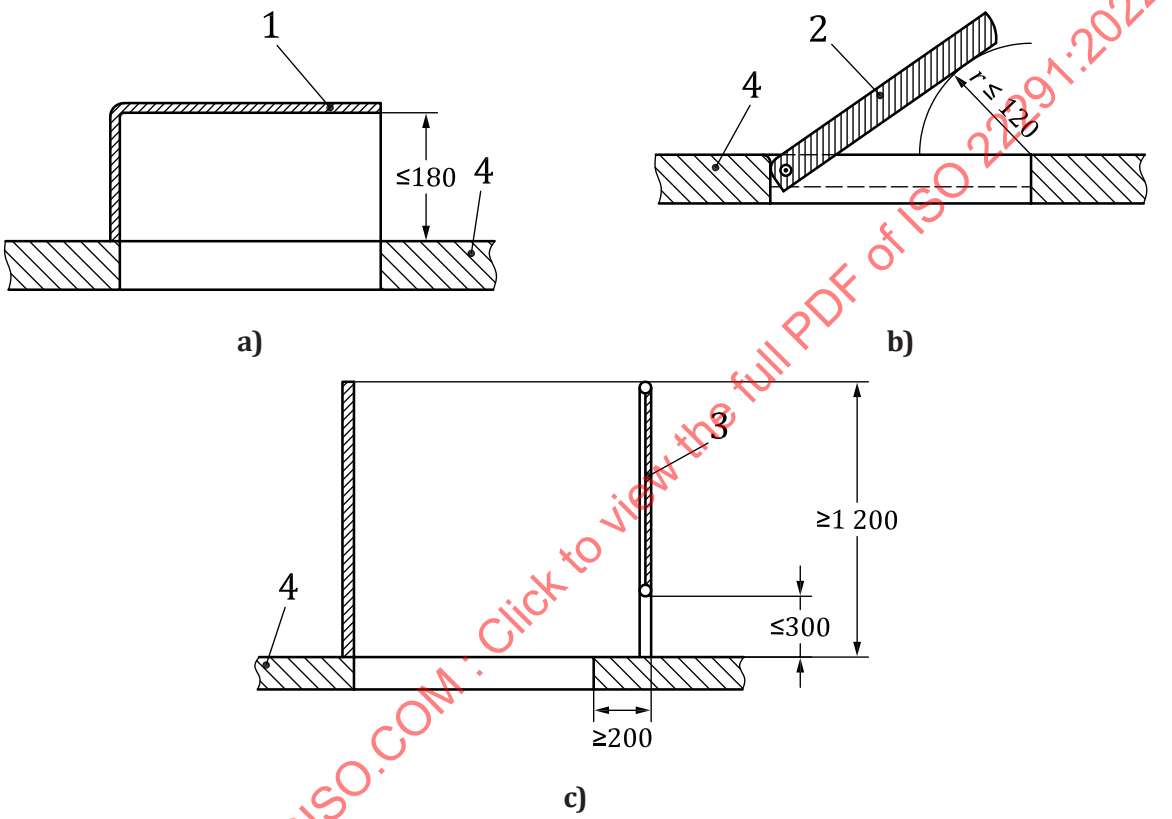
Automatic cleaning devices shall be preferred to hand-held devices. Such hand-held devices can, for example, be compressed air devices and equipment, liquid spray guns, broke hooks, etc. These devices shall be ergonomically designed and shall be provided by the user.

Where manual cleaning of rolls or cylinders is required, the instructions handbook shall contain information about the safe working practices.

For machines or machine sections equipped with a reversing function for cleaning or removal of broke, this can create new danger points that require safeguarding. Where such hazards exist, reverse operation shall only be possible in jogging mode (hold-to-run control according to IEC 60204-1:2016, 9.2.7.3). The actuator for starting the reverse motion shall be protected against inadvertent operation, e.g. by shrouding or by covering with a movable plate or special mode of operation.

Where gaps are provided on the drive and front sides of the machine, see Figures 2 and 3, to facilitate the removal of broke, such gaps shall be in accordance with Figures 2 and 3.

Dimensions in millimetres



Key

1 fixed hood with side opening

2 movable flap with limited opening width

3 fixed side barriers with side opening in the lower section, ≤ 300 mm in accordance with ISO 13855:2010, 6.2.2 a)

4 floor (standing level)

Figure 2 — Protection against falling from a height at discharge openings for broke

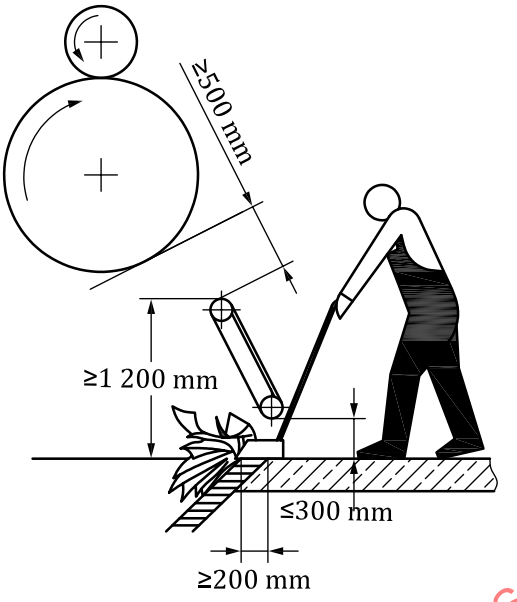


Figure 3 — Protection against falling from a height on recovery pulper under the winder

Where doctor blades are applied to the roll or cylinder pneumatically, hydraulically or by electrical power, the crushing point shall be safeguarded as follows:

— Use of a hold-to-run control in a local control mode if a crushing hazard for the whole hand/arm exists. The related control system shall comply with at least PL = c in accordance with ISO 13849-1:2015 or SIL = 1 in accordance with IEC 62061:2021.

— If the maximum stroke is 25 mm and if a crushing hazard exists only for fingers, the distance between the control device and the danger zone shall be at least 1,10 m, so that the operator can overlook the danger zone, but cannot reach it easily.

— Use of a remote control when the crushing point cannot be reached.

Manually operated devices for energy disconnection shall be provided in the vicinity of the machine or machine section to de-energize the doctor blade actuator.

Crushing hazards between oscillating showers and fixed parts of the machine shall be avoided by applying the minimum gaps according to EN 349:1993+A1:2008. Where this is not possible, fixed guards in accordance with ISO 14120:2015 shall be provided.

Access to high-pressure showers and spray showers with a supply pressure of more than 1,5 MPa (15 bar) shall be prevented by fixed impervious guards in accordance with ISO 14120:2015. This also applies to the machine underside.

Where hand-held water or air lines are used for machine cleaning, equipment shall be provided which allows easy and ergonomic handling of lines to avoid tripping or falling hazards caused by lines lying around. This includes:

— automatic reeling devices for hoses which are used frequently;

— providing several supply stations in order to keep hose lengths short;

— movable hose suspension systems mounted on an elevated guide rail;

— ergonomically designed equipment for manual storing of hoses.

Where conveyors are used in processes where it is likely that materials (e.g. fibres) will accumulate on the surfaces of the conveyor or pulleys, the conveyor shall be designed and constructed to allow cleaning to be done without removing the guards, as far as possible. Fixed cleaning devices shall be

fitted, where possible. If guards have to be removed regularly for cleaning purposes, they shall be interlocked (see ISO 14120:2015, 6.4.4).

The instructions handbook shall contain instructions for safe removal of waste and cleaning. This includes:

a) use of equipment described in 5.19;

b) function and use of stopping devices described in 5.9;

c) use of personal protective equipment;

d) prohibiting unsafe working practices, e.g. manual intervention with the machine running, climbing onto machine frames, accessing into danger zones, defeating of safety devices;

e) instructing operators.

5.19.2 Crosswalks

Movable interlocking guards with guard locking shall be provided if access to the danger area for removal of broke or cleaning is required. Interlocking and guard locking devices shall conform to ISO 14119:2013. The interlocking shall comply with at least PL = c in accordance with ISO 13849-1:2015 or SIL = 1 in accordance with IEC 62061:2021.

5.20 Noise

5.20.1 General

Wetlaid-nonwoven machines shall be designed in such a way that risks resulting from the emission of airborne noise are reduced.

Machine components with high noise emission are, for example, vacuum equipment, compressors, blowers, edge trimming exhaust fans, pneumatic control elements, gears, drives, electric drive system and power transmission elements, hydraulic aggregate, ventilation system, high-pressure pumps, fans, water-jet nozzles and suction units.

5.20.2 Risk

Hearing loss and physiological disorders (as occupational diseases) and interference with oral communication and acoustic warning signals (as source of accidents), generated from fast-rotating machine elements, fast traversing machine elements, flowing fluids and other loud sources on the machines.

5.20.3 Safety requirements

Noise control measures shall be implemented in the following order:

a) Noise control by design measures at the source:

In an early phase of machine design, full attention shall be paid to the noise emissions presumably emanating from the various machine elements, and ways shall be found to avoid, eliminate or reduce them. When designing the machine, suitable noise reduction measures according to state-of-the-art technology and ISO/TR 11688-1:1995 shall be selected.

Specific noise reduction measures by manufacturer are, for example:

— noise-optimized vacuum piping;

— silent gear toothing;

— noise reducing hoods and enclosures with tightly shutting doors and openings;

— vibration-dampened installation of the machines;

— low-noise gear boxes and drives.

NOTE ISO/TR 11688-2:1998 gives useful information on noise generation mechanisms in machinery.

b) Noise reduction by protective measures:

Further measures that can be implemented by the manufacturer or the user are noise encapsulations of the machine, screens and silencers.

NOTE Design details and methods for measuring the acoustic performance of these measures can be found in ISO 11691:2020, ISO 11821:1997, ISO 14163:1998, ISO 11546-1:1995, ISO 11546-2:1995, ISO 11820:1996 and ISO 15667:2000.

Noise reduction measures by the user of the machine are, for example:

— acoustic measures in the machine hall to reduce sound pressure levels;

— low-noise design of the ventilation system and ducts in the ventilation and heat-treatment rooms;

— installing noisy equipment (e.g. high-pressure pumps and fans) in separate rooms.

This list of technical measures for noise reduction only gives a few examples and is not meant to be complete. If the means of noise reduction at the source are not sufficient to avoid health risks, sound-proof cabins for workplaces shall be provided where practicable.

c) Noise reduction through information:

The manufacturer shall give information (see 8.2) on the residual risks remaining after carrying out the technical measures for noise reduction.

5.21 Hot surfaces

5.21.1 General

Machines shall be designed so as to reduce the risk of burn injury caused by intended or non-intended contact with or proximity to machine parts, process material at high temperatures or to flames.

5.21.2 Risk

Generated by contact of persons with hot surfaces of machines or vessels used or with flames or in the proximity of radiation heaters (e.g. infrared heaters), there is a risk of burns. The hot surfaces result from the incorporation of purposely heated parts to directly assist and further the production process (i.e. heated rolls, tubes, burners or plates), or are generated in the course of the production process, even extending to the entire vessels themselves, due to the hot liquids or steam they contain.

5.21.3 Safety requirement

Where access to machinery parts with hot surfaces is required or unintentional contact is possible, safety measures to prevent contact are required in accordance with ISO 13732-1:2006.

Adequate protective measures are, for example, guards, isolation, thermal insulation, remote control and refrigerants.

The surface temperatures of machine parts, insulation, shields or guards shall not exceed the values given in ISO 13732-1:2006.

Where, for technical reasons, these limits cannot be achieved, a warning shall be given on the machine in close proximity to the hazard such that the warning can be related to the hazard and visible before

exposure to the hazard occurs, and information shall be given in the instructions handbook concerning instruction and training of operators and the use of personal protective equipment.

On dryers, warning signs “Hot surfaces” shall be provided.

5.22 Static electricity

5.22.1 Hazard

Static electricity can be unintentionally generated in the course of the production process and result in the discharge of sparks, which can cause fire or explosion, or shocks to persons contacting parts charged by process materials.

5.22.2 Safety requirement

Appropriate measures to prevent the build-up of static electricity or to discharge shall be provided.

To prevent the generation of static electricity, suitable materials from which the machine is constructed shall be used.

To discharge static electricity, one of the following measures or any combination thereof shall be taken:

— providing an earthed protective conductor on the conductive parts of the machinery or installation.

— fitting static eliminators in appropriate positions on machinery;

— providing information in the instructions handbook on avoiding static electricity. This information can be given, for example, by indicating the minimum humidity to be provided by the air-conditioning system or by providing instructions on how to avoid over-drying.

5.23 Machine integrated lighting

The requirements of EN 1837:2020 shall be satisfied.

Lighting systems shall be positioned in such a way that they do not cause obstructions in the passage height required in 5.5. Also, the arrangement and selection of lighting units shall take account of possible dangers of fire and wetness.

In the event of a failure of the overall lighting system, an emergency lighting of at least 3 lx shall be provided.

5.24 Ergonomic principles

5.24.1 Hazard

Neglect of ergonomic principles leads to excessive or repetitive efforts. Impairment to health and the risk of accident can be the result.

5.24.2 Safety requirement

Machines shall be designed and built according to the ergonomic principles specified in EN 614-1:2006+A1:2009 and EN 614-2:2000+A1:2008. The machines shall be designed to avoid any awkward body postures. For loads of more than 25 kg, means of transport and lifting shall be provided. Auxiliary means required for make-ready shall be made available and described. Wetlaid-nonwoven machines shall correspond with the ergonomic principles described in ISO 12100:2010, 6.2.8, EN 614-1:2006+A1:2009, EN 1005-1:2001+A1:2008, EN 1005-2:2003+A1:2008, EN 1005-3:2002+A1:2008 and EN 1005-4:2005+A1:2008.

Actuators and warning signs shall be designed in accordance with EN 894-1:1997+A1:2008, EN 894-2:1997+A1:2008, EN 894-3:2000+A1:2008 and EN 894-4:2010.

Special attention shall be given to the following aspects and instances:

a) removal of broke;

b) threading of tail and web;

c) ergonomic body postures;

d) mass of manually handled machine parts, e.g. spacer blocks in the cantilevered wire section of former;

e) cleaning of rolls;

f) changing of rolls;

g) changing of felts, wires and rolls;

h) changing of doctor blades and nozzles;

i) location of actuators.

5.25 Materials and chemical substances, hazardous substances

To avoid contact with hazardous chemical substances, measures shall be taken. The safety requirements given in ISO 14123-1:2015 shall apply.

In the instructions handbook, the machinery manufacturer shall state those materials or substances for which the machine has or has not been specifically prepared.

5.26 Laser

Burning generated by contact with lasers (e.g. monitoring devices). When using lasers, e.g. in measuring devices, the requirements of IEC 60825-1:2014 shall apply.

5.27 Radiation

To avoid radiation damage generated by non-ionizing or ionizing radiation, e.g. radio frequency (high-frequency dryers), infrared radiation (infrared dryers), lasers (monitoring devices) or β rays (monitoring devices), the safety requirements of EN 12198-1:2000+A1:2008 and EN 12198-3:2002+A1:2008 shall apply.

A warning sign "Radiation hazard" shall be provided if a radioactive source is in the measuring device.

5.28 Fire

5.28.1 Hazard

Fire hazards can be generated in a variety of processes, caused by combustion of fire hazardous materials, through contact with hot bearings, sparks resulting from metallic impurities, electrical sparks, and in various processes from the overexposure of the process material or fabric to hot surfaces, radiators or burners.

5.28.2 Risk

Fire poses the risk of burns or inhalation of toxic fumes.

5.28.3 Safety requirements

The requirements of ISO 19353:2019 shall be satisfied as applicable. For overload and overheating protection of electrical equipment, see IEC 60204-1:2016, Clauses 7, 13 and 15.

The requirements of EN 746-1:1997+A1:2009, 5.8.3, shall be satisfied as applicable.

A description of safe procedure for extinguishing fires shall be contained in the instructions handbook.

5.29 Machine elements and their combinations

5.29.1 Power transmission enclosures

5.29.1.1 General

Power transmission enclosures are normally used to house the drives of a machine when these are grouped together to serve a multiplicity of identical production points, or to serve a series of related processing elements. They are normally located at the ends or sides of machines.

5.29.1.2 Hazards

Mechanical, from drives including belts, chains and sprockets, pulleys and gears, in particular, entanglement, drawing-in or trapping.

5.29.1.3 Risks

Occasional access during special operation leading to a high probability of severe injury.

5.29.1.4 Safety requirements

Drives shall be provided with fixed or movable enclosing guards (see Table 2), as follows. The following measures shall be taken:

a) Fixed enclosing guards shall be fastened in accordance with Table 2 and ISO 14120:2015, 5.19.

b) Where special operations are necessary (e.g. checking and adjusting process controls), the machine shall be designed such that operations can be carried out without opening the enclosing guards; otherwise c), and d) shall be complied with.

c) Where b) cannot be complied with and enclosing guards have to be opened more than once per working shift, they shall be movable and interlocked according to Table 2. Where enclosing guards have to be opened once or less per working shift then fixed guards are sufficient.

d) Reference shall be made in the instructions handbook to special operation conditions.

5.29.2 Particularly dangerous machine elements

5.29.2.1 General

These are machine parts fitted with cutting blades and pegs (including rolls, cylinders and belts) found on wetlaid-nonwoven machines.

5.29.2.2 Hazards

Mechanical hazards, from such rolls, cylinders, cutting blades, lattices, etc., in particular, entanglement, drawing-in or trapping, and severe abrasion, especially when such elements have a long stopping time.

5.29.2.3 Risks

Occasional access during normal and special operation, in particular, to remove laps and blockages, leading to a high probability of severe or fatal injury.

5.29.2.4 Safety requirements

a) To prevent contact with particularly dangerous machine elements, enclosing guards (e.g. casings, covers) shall be provided (see Table 2).

   Fixed enclosing guards may only be used where access is necessary exclusively for major repair.

   Movable enclosing guards shall be interlocked according to Table 2. Where the longest stopping time (usually when empty of process material) exceeds the access time to the hazard, means shall be provided to ensure that the movable enclosing guards cannot be opened or removed until all moving particularly dangerous elements have been brought to a standstill. For example, an interlocking device with guard locking in conjunction with a motion sensor may be used for this purpose. The guard locking device shall operate even when the control system or power supply fails. If necessary, to achieve the required stopping time after an interlock with guard locking is provided, a brake shall be used.

b) Feed hoppers as well as inlet, discharge, observation, cleaning and other openings shall be in accordance with one of the following:

   1) so positioned that access to particularly dangerous moving parts is prevented (i.e. the distance from the edge of the opening to the moving part shall comply with ISO 13857:2019, Table 2);

   2) fitted with a lattice of bars or similar items within the openings allowing access by operating tools; the distances between the bars shall be such that hand or finger access to the danger zone is prevented in accordance with ISO 13857:2019, Table 4;

   3) fitted with an interlocking guard with guard locking to cover those openings, unless the access time always exceeds the stopping time, in which case an interlocking guard without locking may be used.

c) For normal starting up of particularly dangerous machine elements during special operations (e.g. maintenance, adjustment, make-ready, elimination of process faults), see 5.16.

d) Where a mode selector is provided in combination with the requirements of 5.16, it shall not be possible to alter the mode before the machine has come to a standstill.

e) The safety-related part of the control system including interlocks of particularly dangerous machine elements shall comply with at least PL = c in accordance with ISO 13849-1:2015 or SIL = 1 in accordance with IEC 62061:2021.

5.29.3 Machine elements which normally do not require safeguarding

5.29.3.1 Machine elements out of reach

On wetlaid-nonwoven machinery, dangerous mechanical or thermal machine elements can be arranged such that they cannot be reached from the ground, access stairs or stationary working platforms work ways.

5.29.3.2 Hazards

Hazards from dangerous machine elements which are normally out of reach but can be reached from a mobile platform or a ladder during the performance of special operations.

5.29.3.3 Risks

Infrequent access during special operation when the machine is run under normal operating conditions leading to a low probability of minor to severe injury.

5.29.3.4 Safety requirements

Dangerous machine elements which cannot be reached during normal operation but which can be reached during special operations, e.g. by use of a movable ladder, need not to be guarded provided that:

— the special operation can be performed with the dangerous machine elements stopped or a safe running condition achieved (see 5.16);

— the machine elements can be rendered non-dangerous by movement to safe positions.

The instructions handbook shall give full instructions for performing the special operations in the conditions described above.

5.30 Rolls and rotating shafts

5.30.1 Rolls

5.30.1.1 General

Rotating rolls in pairs or groups, rolls rotating adjacent to fixed parts or rolls with an on-running conveyor or process material, and rough-surfaced rolls, are found on wetlaid-nonwoven machines.

In-running nips are danger points caused by rotating roll, cylinder or roll nips where persons, parts of the body or clothing can be drawn in.

Such nips arise between:

a) counter-rotating parts;

b) a rotating part and an adjacent fixed part;

c) parts rotating in the same direction, but with different peripheral speeds and surface properties, if adequate safety distances are not maintained.

Nips higher than 2,70 m do not require any special guard.

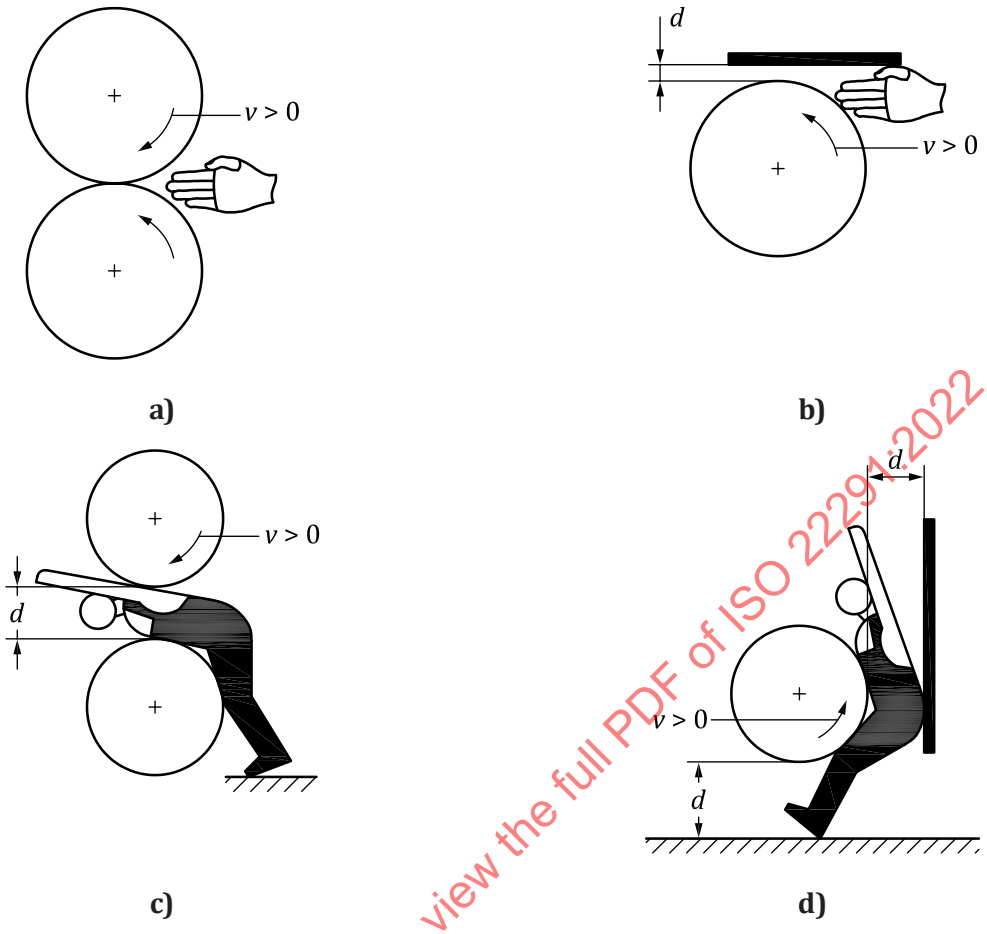
5.30.1.2 Hazards

5.30.1.2.1 General

Mechanical, from rolls, in particular, entanglement, drawing-in or trapping, crushing and friction or abrasion.

5.30.1.2.2 In-running nips

Examples of in-running nips are given in Figure 4.



Key

v circumferential speed

d distance

Figure 4 — Examples of in-running nips

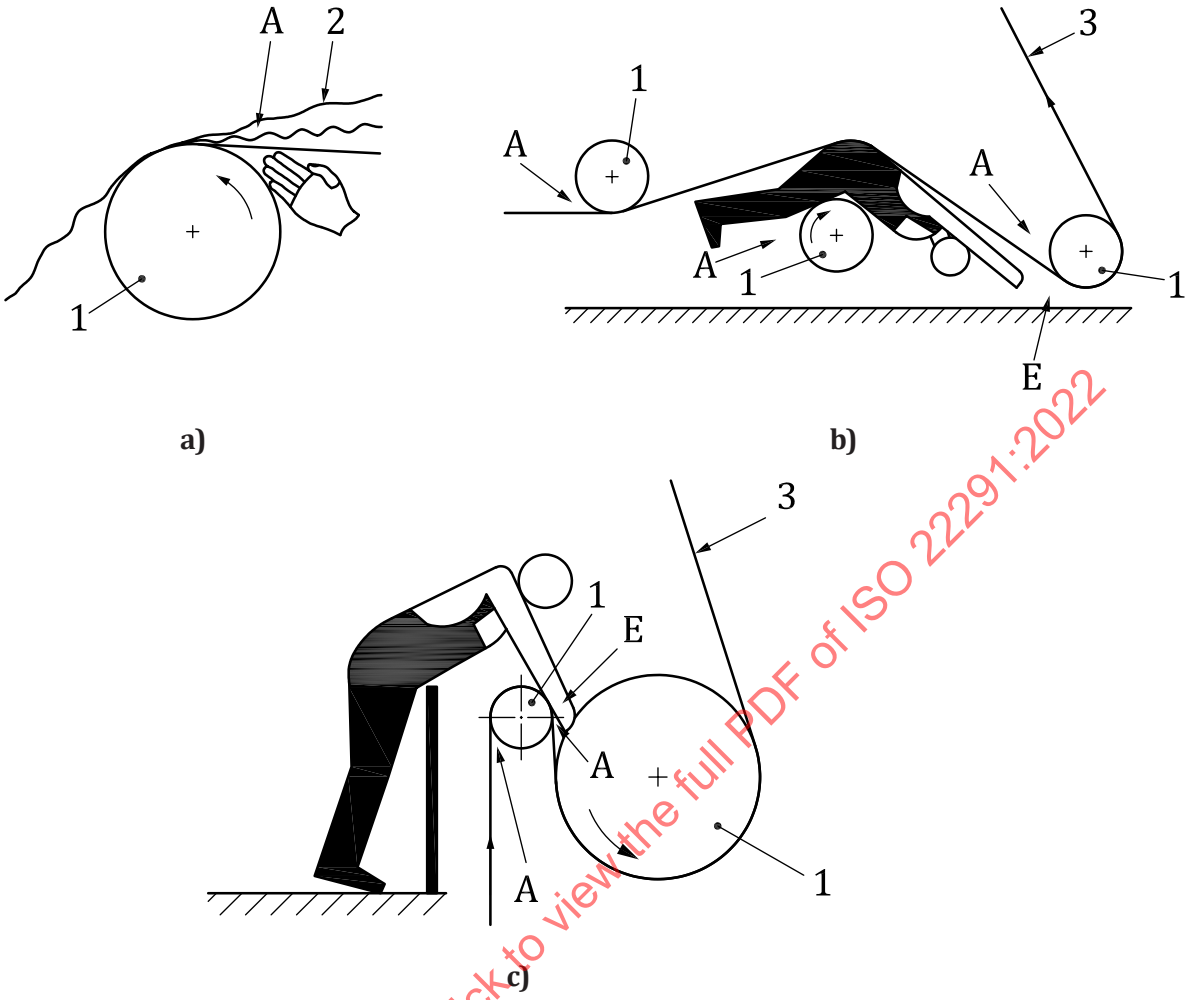
NOTE 1 The hazard of the whole body being drawn in is prevented if there is a safety distance, *d*, of 500 mm between machine parts at the in-running nip.

NOTE 2 The hazard of an arm being drawn in is prevented if there is a safe distance, *d*, of at least 120 mm between machine parts at the in-running nip.

5.30.1.2.3 Wrapping points

Danger points where moving materials, such as felts or screens and wires, aprons or ropes or strong material webs, are fed onto moving parts, such as rolls, cylinders or disks, which can draw in persons, parts of the body or clothing.

Examples of wrapping points are given in Figure 5.



Key

A wrapping point
E in-running nip
1 roll, cylinder
2 rope
3 felt, wire

Figure 5 — Examples of wrapping points

5.30.1.3 Safety requirement for in-running nips and wrapping points

a) Prevention of drawing-in of fingers, hands, arms or feet by use of an appropriate spacing (gap) between the rolls.

The gap between any pair of counter-rotating rolls, or between any pair of rolls rotating in the same direction but with different circumferential speeds or surface covering, shall be for fingers greater than 25 mm and for hands, arms and feet greater than 120 mm.

b) Prevention of drawing-in of head and body by use of an appropriate spacing (gap) between the rolls.

The gap between any pair of counter-rotating rolls, or between any pair of rolls rotating in the same direction but with different circumferential speeds or surface covering, shall be for the head greater than 300 mm and for the body greater than 500 mm.

c) Safeguarding of drawing-in points between rolls (see Table 2).

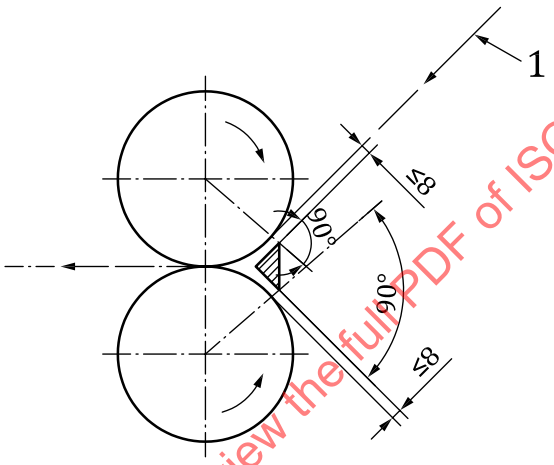
Where a) or b) cannot be complied with, guards and safety devices shall be provided in accordance with one of the following:

1) Fixed enclosing guard. Openings within these guards for the passage of process material shall comply with the dimensions given in ISO 13857:2019.

2) Fixed nip guards close to the drawing-in point, type of guard arranged directly on the nip of a pair of rolls or some other nip.

The profile of the nip guard shall be formed such that at the outer edge it runs parallel to the tangent of the roll surface to avoid a wedge effect (see Figure 6).

Dimensions in millimetres



Key

1 process material

Figure 6 — Nip guard arrangement

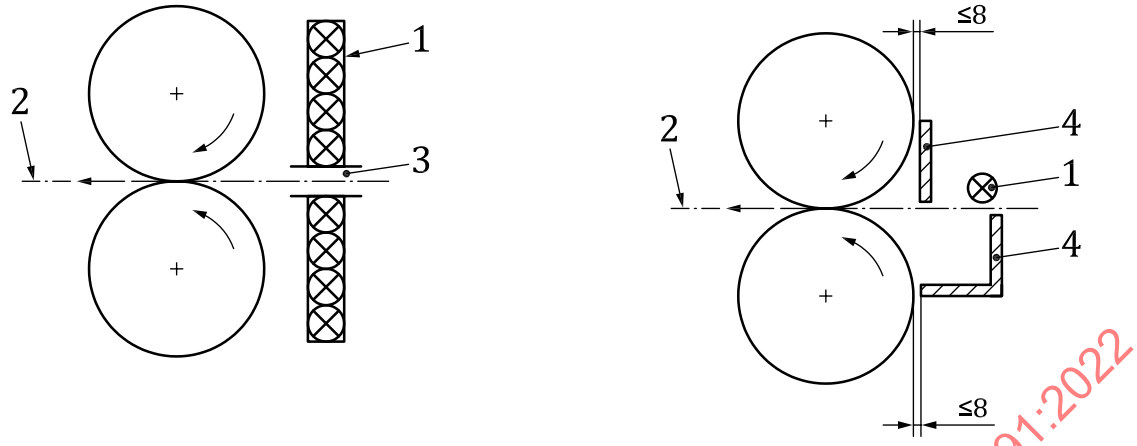
Round guards shall not be used because they themselves can create a drawing-in point, together with the adjacent roll surface.

When positioning a guard in close proximity to a rotating surface, a new drawing-in point can be created between the edge of the guard itself and the rotating surface. In order to prevent a danger point being thus created, care shall be taken to ensure that the gap is as small as technically possible with regard to the process. In deviation from ISO 13857:2019, a gap of ≤ 8 mm (see Figure 6) shall be used.

3) Interlocking movable guards and, if stopping time exceeds access time to the hazard, with guard locking according to Table 2.

4) Active AOPD in accordance with Table 3 shall be arranged such that the AOPD is activated in the case of access to the drawing-in point and the rolls have come to a standstill or have moved apart to a sufficient distance [see 5.30.1 a) for distances] before the operator can reach the drawing-in point, e.g. as shown in Figure 7 a). When necessary, in order to meet this requirement, with practicable distances between the AOPD and the drawing-in point, the time necessary to reach the drawing-in point shall be increased, e.g. by barriers as shown in Figure 7 b).

Dimensions in millimetres



a) Without barrier **b) With barrier**

Key

1 AOPD
2 process material
3 blanked area for process material
4 barrier

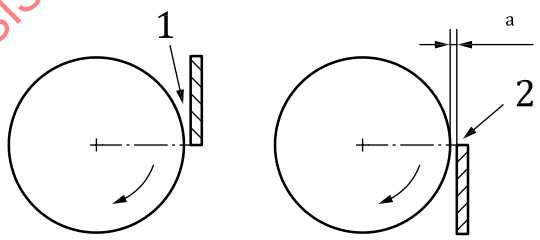
Figure 7 — Protection by AOPD

d) Prevention of drawing-in from reverse side. For special operations, see 5.16.

e) Safeguarding of drawing-in points between rolls and fixed machine parts (see Table 2).

For danger zones between a roll and a fixed part of a machine or structure next to the machine which is adjacent to the roll, either gaps of dimensions according to 5.30.1.3 a) or guards or safety devices according to 5.30.1.3 c) shall be provided. Alternatively, but only when a wedge effect (as shown at x in Figure 8) does not exist, a distance between the surface of the roll and the fixed part of less than 8 mm (see Figure 6), as shown at y in Figure 8, may be used as the unique measure.

Dimensions in millimetres



Key

1 wedge effect
2 no wedge effect
a Distance between roll and fixed machine part ≤ 8.

Figure 8 — Avoidance of wedge effect

f) Prevention of drawing-in between adjustable rolls.

Where rotating rolls in pairs or stacks normally run in direct contact with each other but can also be run with a gap between them, at either production speed or a slower speed, the guard or safety

device chosen shall prevent access to the danger point when the rolls are closed. When the rolls are being run in their separated position, this shall not give rise to a new danger point between any part of the machine and the moving surface of the rolls. Where such a new danger point cannot be avoided, an additional safety device according to Table 3 shall be provided (e.g. SPE).

g) Safeguarding of drawing-in points between rolls and on-running process material (see Table 2).

Drawing-in points shall be provided with a guard or other safeguard in accordance with the following and 5.3:

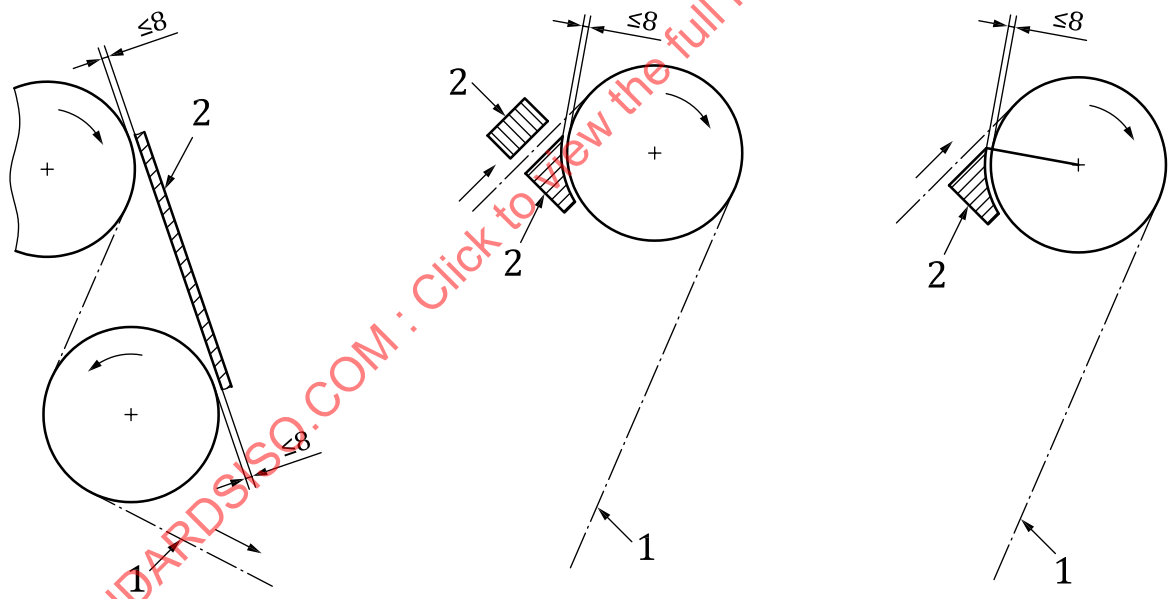
1) a fixed or interlocked movable distance guard in accordance with Figure 9 a);

2) guards covering both the drawing-in point and the top side, in accordance with Figure 9 b); the latter should be interlocked to the drive, where low tension or low-stiffness process material would otherwise allow encroachment;

3) nip guards with profiles in accordance with Figure 9 c), where either the tension or stiffness of the process material, in itself prevents encroachment, and where such nip guards shall prevent access to the drawing-in point between the process material and the roll;

4) safety devices such as pressure-sensitive mats or AOPDs extending the full width of the drawing-in point, where such safety devices shall, when actuated, stop the drive to the rolls.

Dimensions in millimetres



Key

1 process material

2 guard

Figure 9 — Guards for on-running process material

h) Safeguarding several rolls by one guard (see Table 2).

A series of rolls may be protected by one guard (e.g. fence guard, distance guard).

i) Measures relating to special operations.

For starting up rolls during special operations (e.g. maintenance, adjustment, make-ready, elimination of process faults), see 5.16.

j) The safety-related part of the control system concerning drawing-in points of rolls or rolls and fixed parts shall comply with at least PL = c in accordance with ISO 13849-1:2015 or SIL = 1 in accordance with IEC 62061:2021.

Front sides of rolls that can be accessed shall have a smooth surface.

Full body access and falling onto running rolls which are located such that their top level is lower than 1,10 m above the access level shall be prevented by:

— machinery frames with a minimum height of 1,10 m;

— railings or fixed guards with a minimum height of 1,10 m;

— interlocking movable guards with a guard locking device in accordance with ISO 14119:2013, interlocked with the roll drive if access for removal of broke or cleaning is required. The interlocking shall comply with at least PL = c in accordance with ISO 13849-1:2015 or SIL = 1 in accordance with IEC 62061:2021.

For guarding in-running nips and wrapping points created by the rolls, 5.3 and 5.30.1 apply.

5.30.2 Rotating shafts

5.30.2.1 General

Rotating shafts used to transmit drive power are found on wetlaid-nonwoven machines and similar machines.

5.30.2.2 Hazards and risks

Mechanical hazards from the shafts, in particular, entanglement of the hair and clothing.

5.30.2.3 Safety requirements

a) Rotating shafts shall, where possible, be positioned in accordance with ISO 13857:2019 so that they are not exposed.

b) Exposed rotating shafts shall be provided with guards (e.g. fixed distance guards or tunnel guards), or fixed housing according to ISO 14120:2015 (see Table 2).

c) The precautions shall also apply to shafts at the rear of frames which are accessible during special operations.

d) Smooth shaft ends protruding a distance of no more than a quarter of the diameter and no longer than 5 cm do not need to be safeguarded.

5.31 Doors and lids

5.31.1 Hazards

Doors and lids are variously used on wetlaid-nonwoven machines. On fence-type enclosures equipped with interlocking doors, it shall be possible to open the doors from inside the enclosed area at any time so that persons locked in can escape from the danger zone.

A mechanical hazard exists, from edges of the door or lid, in particular, impact, crushing and shearing.

5.31.2 Risks

Access while the door or lid is opening or closing, leading to a low probability of moderate-to-severe injury.

5.31.3 Safety requirements

a) Means shall be provided to prevent opened doors and lids from falling unintentionally, e.g. including where there is a risk of the door or lid falling from its open position, a catch or a stop beyond the hinge, or other device to hold it securely in the open position;

b) For hand-operated doors and lids, the movement of the door or lid shall take into account ergonomic considerations and mass (inertia). See 5.24 and Clause A.3.

5.32 Entry into machines or items of installation

5.32.1 Hazards

Mechanical hazards, when an operator enters installation and can be injured or shut inside with the machine functioning. Risk of crashing when entering on machine elements.

5.32.2 Risks

During normal and special operation, low probability of severe or fatal injury.

5.32.3 Safety requirements

a) If doors provide access to the hazardous zone, they shall be interlocked with the machine. When the run down time is sufficient to allow access to dangerous parts, interlocking with guard locking shall be provided (see Table 3).

b) The machine shall not be restarted by closing an access door, but only by actuating the start control at the control panel. Every access point shall be fitted with a manually operated reset control system, e.g. reset control or trapped key system, unless all danger points can be viewed from the control panel. The reset control system shall not be capable of being actuated from a danger zone. The reset control shall be inoperative while a door is open. The start control shall be effective only when all doors are closed and all reset control systems have been actuated.

5.33 Cutting units

5.33.1 Hazards

Circular knives, water-jet knives and guillotine-type blades are used on wetlaid-nonwoven machines (e.g. in equipment of automatic winders).

Mechanical hazards from the cutting device, in particular, cutting or severing, with water-jet knives through the exhalation of high pressure operating medium, and/or from the blade supports, in particular, crushing and shearing.

5.33.2 Risks

Occasional access during normal and special operation, leading to a high probability of minor cuts and a low probability of severed fingers, hands or arms. High probability of moderate-to-severe injury when handling knife blades.

5.33.3 Safety requirements

5.33.3.1 General

Circular knives shall be guarded to prevent finger contact, except for the part required to cut. So far as practicable, knife enclosures shall not need to be dismantled when changing the knife.

5.33.3.2 Fixed-position circular knives

Enclosing guards shall be provided, which enclose the knives so far as practicable in relation to the process being carried out (see Table 2). These shall be adjustable or self-adjusting.

5.33.3.3 Traversing circular knives

Access to the blades and associated parts including any clamp which, together with fixed machine parts, form crush and shear points when traversing shall be prevented.

This requirement can be achieved by a fixed guard extending the length of the traverse, or SPE (e.g. AOPD) preventing the start of the traversing motion or causing it to be interrupted immediately if an operator reaches into the danger zone (see Tables 2 and 3).

The cutting surfaces of movable or pivotable knives shall be guarded to prevent accidental contact in their resting position. For safeguarding the danger zone, the safety devices specified in 5.3 shall be used.

5.33.3.4 Guillotine-type blades

Means shall be provided to prevent access to the danger zone while the blade is in motion. For example, this can be achieved if, on entry and exit sides of the blade, tunnel guards are provided whose dimensions correspond to ISO 13857:2019. Movable guards with an interlocking device in accordance with ISO 14119:2013 shall be provided on the access points to the blade. Movable guards (e.g. hinged covers) within the tunnel shall be interlocked with the blade (see Table 2).

If such a cutting device is incorporated in an installation having fence guards (see Table 2), access doors interlocked with the movement of the blade shall be provided in front of, and behind, the cutting device (see Clause A.2). If fence guards are not provided, the work area shall be secured by means of safety devices (e.g. an AOPD system or pressure-sensitive mats or floors), which prevent movement of the blade as long as a person can reach it (see Table 3). The stopping time shall be shorter than the access time to the blade.

Interlocking devices of guards and fixed parts of guillotine-type blades shall comply with at least PL = c in accordance with ISO 13849-1:2015 or SIL = 1 in accordance with IEC 62061:2021.

For the protection of the operator during the changing of blades, mechanical restraints shall be provided to prevent the blade carrier from falling.

5.33.3.5 Water-jet knives and cut-off knives

Water-jet knives and cut-off knives liable to cause injury shall be guarded with fixed guards according to ISO 14120:2015 and in accordance with the safety distances of ISO 13857:2019, Tables 2 and 4.

If frequent access is required (access to be greater than once per working shift), interlocking guards with guard locking in accordance with ISO 14119:2013 and ISO 14120:2015 shall be provided.

If access during normal operation is required either of the following shall be provided:

— pressure-sensitive mats according to ISO 13856-1:2013;

— electrosensitive protective devices (ESPDs) type 2 or 4 according to IEC 61496-1:2020.

The control system related to the interlocking of these devices shall comply with at least PL = c in accordance with ISO 13849-1:2015 or SIL = 1 in accordance with IEC 62061:2021. ISO 13855:2010 shall be applied. The safety distances of ISO 13857:2019, Table 2, for distance guards and the safety distances of ISO 13857:2019, Tables 3 and 4, for guards with openings shall be taken into account.

The instructions handbook shall contain instructions for changing and sharpening of knives.

5.34 Machine specific tools

Machine-specific tools shall be designed on the principles of EN 614-1:2006+A1:2009 and EN 614-2:2000+A1:2008. Machine-specific tools are, for example:

— hooks and pushers for removal of broke;

— special tools for jacking and lifting;

— mechanical safety locking tools;

— tools for knife changing.

5.35 Whole body access to confined spaces

If access to confined spaces is required, the following shall be given in the instructions handbook:

— a list of all confined spaces where whole body access is required;

— the safety measures to be observed to allow safe access.

For principles for determining the dimensions required for openings for whole body access into machinery, see EN 547-1:1996+A1:2008.

5.36 Tail and web threading equipment

5.36.1 Manual web threading

Manual web threading shall be done according to Table 12.

Table 12 — Crawl speed

Application	Maximum speed m/min	Maximum stopping distance mm
Crawl speed	15	100

Hold-to-run controls together with a crawl speed (see Table 12) shall be provided. Release of the control actuator shall lead to a stop of category 0 or 1 (see IEC 60204-1:2016). The position of the control actuator shall be chosen to ensure unlimited view to the hazardous area.

Crawl speed combined with an emergency stop, which results in a stopping distance according to Table 12, shall be provided.

Manual web threading devices for special operations shall only be activated by means of a mode selector (see ISO 12100:2010, 6.2.11.10).

Reference shall be made in the manufacturer's instructions handbook to the correct procedures and precautions for special operations and to the residual risks and the need for specific training of operators to counter these risks. Reference shall also be made to the fact that special operations may only be carried out by authorized and specially trained personnel.

The related control system shall comply with at least PL = c in accordance with ISO 13849-1:2015 or SIL = 1 in accordance with IEC 62061:2021.

5.36.2 Automatic web threading equipment

A combination of devices, including ropes, air flows (blow pipes, air guns), conveyors and vacuum-supported machine elements used to feed a narrow tail (narrow material web) from one machine section to the next up to the reel section; the web is then gradually widened until it spans the full width or deckle of the machine.

Automatic web threading equipment eliminates or minimizes the need of manual intervention for web threading. It shall be reliable and ensure safe threading of the web through all machine sections up to the reel up section.

Power transmission elements between mechanical threading devices and their related drives shall be safeguarded by fixed guards in accordance with ISO 14120:2015 and ISO 13857:2019, Table 4.

5.37 Felts and wires, clothing, fabrics

The risk of tearing of clothing shall be prevented by design, by limiting the tensile load and by selecting the right type of elements that can withstand the foreseeable stresses. The required maintenance intervals shall be specified in the instructions handbook, see 8.2 i). The specified maintenance intervals shall be described in the operation manual.

Automatic devices shall be provided for controlling the alignment of clothing.

Contact with sharp edges of clothing, e.g. when the clothing is at head or neck height, shall be prevented, e.g. by locating wires above passageways at a height of 2,10 m minimum or, where this is not possible, by fixed guards.

In order to ensure safe changing of clothing, machines shall be designed according to the following principles and requirements:

— Working platforms, stairs and fall-off protection shall be designed so that as far as possible the protection remains in position. This can be achieved by, for example, providing hinged walkways with integrated fall-off protection, see also 5.5.

— Auxiliary means for fixing wires, rods, clamps for fitting the pulling ropes to the wire and winches shall be specified.

— Manually inserted filling pieces on the cantilevered wire part shall be provided with handles and should be of light mass, maximum 25 kg. In order for the filling pieces not to cause a tripping hazard, attachments shall be provided, e.g. on the machine frame, for taking up or suspending the pieces.

6 Specific safety requirements and/or protective/risk reduction measures

6.1 Headbox

6.1.1 Specific hazards

Mechanical hazards, crushing, movements for opening and closing of headboxes, swivelling and straight movements of rolls, suction boxes and other adjustable machine parts.

Mechanical risk due to water jet and foreign particles blown up and during cleaning of the installation by high-pressure water jet.

6.1.2 Specific risks

Access to moving parts (e.g. out of operational mode, maintenance, special operation) results in a low probability of fatal injuries or high probability of moderate-to-severe injuries.

When working with high-pressure water jets, moderate-to-severe injuries can occur.

6.1.3 Specific safety requirements:

The closing and opening movements of head boxes and the swivelling or straight movement of rolls, suction boxes and other adjustable machine parts which can be accessed during the movement shall be operated under hold-to-run control and located in such a way that the danger zone can be overlooked by the operator. The related control system shall comply with at least PL = c in accordance with ISO 13849-1:2015 or SIL = 1 in accordance with IEC 62061:2021.

Means shall be provided to prevent head box lids from unexpected closing from a raised position. Safety measures are, for example, mechanical supports or counterweights which are connected to the machine, and for hydraulically operated lids, for example, check valves.

In-running nips and wrapping points on the headbox shall be provided with fixed guards according to ISO 14120:2015 and in accordance with the safety distances of ISO 13857:2019, Tables 2 and 4.

Movable interlocking guards with guard locking shall be provided according to ISO 14120:2015 if access to the danger area for removal of broke or cleaning is required. Interlocking and guard locking devices shall conform to ISO 14119:2013. The control system of the interlocking and guard locking shall comply with at least PL = c in accordance with ISO 13849-1:2015 or SIL = 1 in accordance with IEC 62061:2021. The safety distances of ISO 13857:2019, Table 2, for distance guards and the safety distances of ISO 13857:2019, Tables 3 and 4, for guards with openings shall be taken into account.

Fall protection equipment (e.g. fall arrest) shall be provided if necessary.

6.2 Wire section and jet head

6.2.1 Specific hazards

Mechanical hazards, crushing during swivelling and straight movements, suction boxes and other adjustable machine parts.

Mechanical risk due to water jet and foreign particles blown up and during cleaning of the installation by high-pressure water jet.

6.2.2 Specific risks

Access to moving parts (e.g. out of operational mode, maintenance, special operation) results in a low probability of fatal injuries or high probability of moderate-to-severe injuries.

6.2.3 Specific safety requirements

The swivelling or straight movement of rolls, suction boxes and other adjustable machine parts which can be accessed during the movement shall be operated under hold-to-run control and located in such a way that the danger zone can be overlooked by the operator. The related control system shall comply with at least PL = c in accordance with ISO 13849-1:2015 or SIL = 1 in accordance with IEC 62061:2021.

In-running nips and wrapping points on the wire section/former section shall be provided with fixed guards according to ISO 14120:2015 and in accordance with the safety distances of ISO 13857:2019, Tables 2 and 4.

Movable interlocking guards with guard locking shall be provided according to ISO 14120:2015 if access to the danger area for removal of broke or cleaning is required. Interlocking and guard locking devices shall conform to ISO 14119:2013. The control system of the interlocking and guard locking shall comply with at least PL = c in accordance with ISO 13849-1:2015 or SIL = 1 in accordance with IEC 62061:2021. The safety distances of ISO 13857:2019, Table 2, for distance guards and the safety distances of ISO 13857:2019, Tables 3 and 4, for guards with openings shall be taken into account.

Fall protection equipment (e.g. fall arrest) shall be provided if necessary.

6.3 Hydroentangling unit

6.3.1 Specific hazards

Mechanical hazards, due to water jets, belts, rolls, drums, especially crushing, shearing, being drawn in, splashed or caught.

6.3.2 Specific risks

When persons reach into rolls, belts, drums and jet heads during special operating conditions, there is a low probability of moderate injuries.

6.3.3 Specific safety requirements

The specific safety requirements shall be in accordance with ISO 11111-3:2005/Amd.2:2016, 5.5 "Spunlace machines".

Enclosure of the entire machine with interlocked lifting gate or guard (protective fence) with guard locking according to ISO 14119:2013 shall be provided. Threading procedures in operating condition "crawl speed" (also see 5.36.2) and in jogging mode (hold-to-run control according to IEC 60204-1:2016, 9.2.7.3) according to operating instructions are necessary. In addition, a safety strip according to ISO 13850:2015 shall be installed as an emergency device beside the pull rope at foot height.

The related control system shall comply with at least PL = c in accordance with ISO 13849-1:2015 or SIL = 1 in accordance with IEC 62061:2021.

6.4 Through-air dryer

6.4.1 Specific hazards and risks

Mechanical hazards, by entry and exit rolls during threading of the web, especially being drawn in, caught or crushed between drum and roll.

Thermal hazards, due to hot drums and rolls at entry and exit, especially burning.

During the threading process, there is a low probability of moderate injury.

6.4.2 Specific safety requirements

The specific safety requirements shall be in accordance with ISO 11111-7:2005, 5.5.5.

If the nip is accessible at the entry or exit, a guard according to 5.30 shall be installed and, in addition, a pull rope across the working width as an emergency unit as specified in ISO 13850:2015.

Gas-heated dryers shall be flushed in accordance with EN 746-2:2010, 5.2.3.2, before each start.

The isolation shall be carried out so as to comply with the surface temperature limits of ISO 13732-1:2006, Clause 4.

The related control system shall comply with at least PL = c in accordance with ISO 13849-1:2015 or SIL = 1 in accordance with IEC 62061:2021.

6.5 Quality control system (QCS)

6.5.1 Specific hazards

Mechanical hazards, traversing movement of measuring unit.

Hazard due to ionizing radiation.

6.5.2 Specific risks

When the traversing measuring unit travels from one side to the other, crushing can occur depending on the installation position, leading to a high probability to moderate-to-severe injury.

Improper use can result in a risk of ionizing radiation doses.

6.5.3 Specific safety requirements

Radiometric sensors shall be equipped with condition monitoring with optical status display. The measuring unit shall be designed and shielded to secure that there is no exposure to radiation during normal operating conditions. Interlocked covers or barriers shall be provided.

The sources of the radiometric sensors shall be lockable with a key switch.

Crushing points at the measuring frames shall be provided with the following safeguards and measures:

— Observe minimum distances according to EN 349:1993+A1:2008. Comply with Clause A.3.

— Fixed guards according to ISO 14120:2015 and in accordance with the safety distances of ISO 13857:2019, Tables 2 and 4.

Movable interlocking guards with guard locking shall be provided according to ISO 14120:2015 if access to the danger area for removal of broke or cleaning is required. Interlocking and guard locking devices shall conform to ISO 14119:2013. The related control system shall comply with at least PL = c in accordance with ISO 13849-1:2015 or SIL = 1 in accordance with IEC 62061:2021. The safety distances of ISO 13857:2019, Table 2, for distance guards and the safety distances of ISO 13857:2019, Tables 3 and 4, for guards with openings shall be taken into account.

6.6 Winder

6.6.1 Specific hazards

Mechanical hazards from machine parts and from the process material during the winding operation, in particular, drawing-in or trapping or crushing.

Cutting hazards during handling knives/blades (make-ready, maintenance, assembly and disassembly).

6.6.2 Specific risks

Access during normal operation, particularly start-up of a new batch, and also when the fabric is smoothed and edges are uncurled, leading to a low probability of severe or fatal injury and in other cases to a high probability of minor or moderate injury.

6.6.3 Specific safety requirements

For winders with a ware speed exceeding 2 m/min, the danger points in the winding area shall be safeguarded by preventing access with a fence guard.

The dimensions of the fence guards shall be in accordance with ISO 13857:2019. Additionally, the height shall be at least 1 800 mm and the clearance between the lower edge of the fence guard and the floor shall not exceed 180 mm in order to reduce the possibility of unauthorized access. Additional requirements are given in 5.19, and Figures 2 and 3.

If a fence guard is used, the enclosure shall have an interlocked gate. If the stopping time exceeds the access time to the hazard, the enclosure gate(s) shall have an interlock with guard locking such that the gate remains locked until the winder has stopped. To facilitate the start-up of a winder, the interlocking device may be fitted with an override switch provided that overriding also automatically restricts movement of the winder to crawl speed according to Table 12 by means of a hold-to-run control device