INTERNATIONAL STANDARD

ISO 12643-1

Third edition
2023-11

Graphic technology — Safety requirements for graphic technology equipment and systems —

Part 1: General requirements

Technologie graphique — Exigences de sécurité pour les systèmes et l'équipement de technologie graphique —

Partie 1: Exigences générales

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Foreword

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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 document 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).

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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 130, *Graphic technology,* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 198, *Printing and paper machinery — Safety,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 12643-1:2009), which has been technically revised.

The main changes compared to the previous edition are as follows:

— in 5.3.2, the requirements for guards (fixed guards with hinges, inclusion of examples of fastening devices, e.g. rotary clamping closures, adaptation to ISO 13857:2019) have been revised;

— former 6.5.5 (interlocking with guard locking) has been deleted (related machine-specific requirements are provided in the subsequent parts of ISO 12643 series);

— in 5.3.6, the requirements for hold-to-run controls have been revised;

— in 5.3.8, the requirements for reel unwinding devices, rewinding devices and reel transport systems have been revised (monitoring of the chucking cones, adaptation of the requirements to smaller machinery, monitoring of the circumferential speed with regard to overwinding, area protection, protective devices at rewinding devices with manual or automatic reel change);

— in 5.3.10, the requirements for pile carrier movements at feeders and deliveries have been revised;

— in 5.4.2, the requirements for explosion and fire protection have been revised;

— in 5.4.8.2, the requirements for UV radiation to the cited EN 12198-1:2000 have been adapted: no distinction between UVA and UVB/UVC anymore, reference to effective UV radiation;

— a new subclause (5.4.10) about doctor blades has been added;

— in 5.7.2, information that touch sensitive control devices shall not be used for initiating safety functions has been clarified;

— in 5.7.2.3, colours for controls have been adapted;

— in 5.7.2.5.1.2, the comprehensive requirements for emergency stop devices have been replaced by reference to IEC 60204-1:2016/AMD 1:2021 and ISO 13850:2015 (references to safety functions of IEC 61800-5-2, e.g. STO);

— in 5.7.6, the requirements of ESPDs to IEC 61496-1:2020 and IEC 61496-2:2020 has been adapted; likewise, the heights of the light beams for a 3-beam solution have been adapted;

— in 5.8, the requirements to fixed and portable control station have been adapted;

— in 5.10, the requirements for control systems has been revised:

  — the term "irreversible injuries" has been introduced;

  — an overview table of the performance levels defined in the document has been inserted;

— in Clause 6, detailed listings of the validation methods for all safeguarding measures has been added;

— in 8.3.1, the requirements for instruction handbook with regard to noise emission values and hearing protection have been amended;

— Annex A has been revised and has been converted to a normative annex;

— the list of significant hazards has been moved to Annex B;

— the noise comparison values in Annex D has been added;

— a normative Annex F on occurrence of a hazardous explosive atmosphere has been added;

— an informative Annex G on the relationship between protection zones against explosion and equipment to be used has been added.

A list of all parts in the ISO 12643 series can be found on the ISO website.

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 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);

— 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 and in Clause 5 of this document.

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

This document was developed to harmonize the requirements of the following U.S. and European safety standards:

— EN 1010-1:2004+A1:2010;

— EN 1010-2:2006+A1:2010;

— EN 1010-3:2002+A1:2009;

— EN 1010-4:2004+A1:2009;

— EN 1010-5:2005;

— ANSI B65-1:2011;

— ANSI B65-2:2011;

— ANSI B65-3:2011;

— ANSI B65-5:2011.

Requirements specific to prepress and press equipment and systems, binding and finishing equipment and systems, converting equipment and systems, corrugated board manufacturing equipment and systems and stand-alone platen presses that are not included in this document, are given in subsequent parts of ISO 12643 that contain additional requirements specific to that type of equipment.

Graphic technology — Safety requirements for graphic technology equipment and systems —

Part 1: General requirements

1 Scope

This document provides safety specifications for the design and construction of new equipment used in prepress systems, printing press systems, binding and finishing systems, converting systems, corrugated board manufacturing systems and stand-alone platen presses. It is applicable to equipment used in stand-alone mode, or in combination with other machines, including ancillary equipment, in which all the machine actuators (e.g. drives) of the equipment are controlled by the same control system.

The requirements given in this document are applicable to the equipment covered by ISO 12643 (all parts), unless otherwise noted. This document is intended to be used in conjunction with the applicable part of ISO 12643 that contains additional requirements specific to a particular type of equipment.

This document addresses recognized significant hazards specific to equipment and systems in the following areas:

— mechanical;

— electrical;

— slipping, tripping, falling;

— ergonomics;

— noise;

— UV and laser radiation;

— fire and explosion;

— thermal;

— substances and material used for processing;

— failure, malfunction of control system;

— other types of emissions [e.g. ozone, ink mist, volatile organic compounds (VOCs), etc.].

This document is not applicable to:

— equipment manufactured before the date of its publication;

— ordinary office equipment for digital printing and paper processing, such as digital printers, copiers, sorters, binders and staplers, which is intended for use outside the printing and paper industry;

— winder-slitters and sheeters in paper finishing (sheeters with unwinders);

— office-type collating machines equipped with friction feeders;

— mail processing machines;

— machines used for filling packages (such as machines for shaping, filling, and closing the package); and

— textile printing presses.

The safety principles established in this document can also be applicable to the design of equipment within areas of technology that are not specified in ISO 12643 (all parts).

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 3691-4:2020, *Industrial trucks — Safety requirements and verification — Part 4: Driverless industrial trucks and their systems*

ISO 3864-1:2011, *Graphical symbols — Safety colours and safety signs — Part 1: Design principles for safety signs and safety markings*

ISO 3864-2:2016, *Graphical symbols — Safety colours and safety signs — Part 2: Design principles for product safety labels*

ISO 3864-3:2012, *Graphical symbols — Safety colours and safety signs — Part 3: Design principles for graphical symbols for use in safety signs*

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 7010:2019, *Graphical symbols — Safety colours and safety signs — Registered safety signs*

ISO 7731:2003, *Ergonomics — Danger signals for public and work areas — Auditory danger signals*

ISO 11553-1:2020, *Safety of machinery — Laser processing machines — Part 1: Laser safety requirements*

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

ISO 11689:1996, *Acoustics — Procedure for the comparison of noise-emission data for machinery and equipment*

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 13849-1:2023, *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 13854:2017, *Safety of machinery — Minimum gaps to avoid crushing of parts of the human body*

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

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 14122-1:2016, *Safety of machinery — Permanent means of access to machinery — Part 1: Choice of fixed means and general requirements of access*

ISO 14122-2:2016, *Safety of machinery — Permanent means of access to machinery — Part 2: Working platforms and walkways*

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

IEC 60079-0:2017, *Explosive atmospheres — Part 0: Equipment — General requirements*

IEC 60079-1:2014, *Explosive atmospheres — Part 1: Equipment protection by flameproof enclosures "d"*

IEC 60079-2:2014, *Explosive atmospheres — Part 2: Equipment protection by pressurized enclosure "p"*

IEC 60079-5:2015+AMD1:2022, *Explosive atmospheres — Part 5: Equipment protection by powder filling "q"*

IEC 60079-6:2015+AMD1:2020, *Explosive atmospheres — Part 6: Equipment protection by liquid immersion "o"*

IEC 60079-7:2015+AMD1:2017, *Explosive atmospheres — Part 7: Equipment protection by increased safety "e"*

IEC 60079-10-1:2020, *Explosive atmospheres — Part 10-1: Classification of areas — Explosive gas atmospheres*

IEC 60079-10-2:2015, *Explosive atmospheres — Part 10-2: Classification of areas — Combustible dust atmospheres*

IEC 60079-11:2011, *Explosive atmospheres — Part 11: Equipment protection by intrinsic safety "i"*

IEC 60079-13:2017, *Explosive atmospheres — Part 13: Equipment protection by pressurized room "p" and artificially ventilated room "v"*

IEC 60079-14:2013, *Explosive atmospheres — Part 14: Electrical installations design, selection and erection*

IEC 60079-15:2017, *Explosive atmospheres — Part 15: Equipment protection by type of protection "n"*

IEC 60079-18:2014+AMD1:2017, *Explosive atmospheres — Part 18: protection by encapsulation "m"*

IEC 60079-25:2020, *Explosive atmospheres — Part 25: Intrinsically safe electrical systems*

IEC 60079-26:2021, *Explosive atmospheres — Part 26: Equipment with Equipment Protection Level (EPL) Ga*

IEC 60079-28:2015, *Explosive atmospheres — Part 28: Protection of equipment and transmission systems using optical radiation*

IEC 60079-31:2022, *Explosive atmospheres — Part 31: Equipment dust ignition protection by enclosure "t"*

IEC 60079-33:2012, *Explosive atmospheres — Part 33: Equipment protection by special protection 's'*

IEC 60204-1:2016+AMD1:2021, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements*

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

IEC 60947-2:2016+COR1:2016+A1:2019, *Low-voltage switchgear and controlgear — Part 2: Circuit-breakers*

IEC 60947-3:2020, *Low-voltage switchgear and controlgear — Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units*

IEC 60947-5-1:2016+COR1:2016, *Low-voltage switchgear and controlgear — Part 5-1: Control circuit devices and switching elements — Electromechanical control circuit devices*

IEC 60947-5-3:2013, *Low-voltage switchgear and controlgear — Part 5-3: Control circuit devices and switching elements — Requirements for proximity devices with defined behaviour under fault conditions (PDDB)*

IEC 61010-1:2010+COR:2011+A1:2016, modified+A1:2016/COR1:2019, *Safety requirements for electrical equipment for measurement, control, and laboratory use — Part 1: General requirements*

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

IEC 61310-2:2007, *Safety of machinery — Indication, marking and actuation — Part 2: Requirements for marking*

IEC 61310-3:2007, *Safety of machinery — Indication, marking and actuation — Part 3: Requirements for the location and operation of actuators*

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

ISO 80079-36:2016, *Explosive atmospheres — Part 36: Non-electrical equipment for explosive atmospheres — Basic method and requirements*

ISO 80079-37:2016, *Explosive atmospheres — Part 37: Non-electrical equipment for explosive atmospheres — Non-electrical type of protection constructional safety "c", control of ignition sources "b", liquid immersion "k"*

EN 1127-1:2019, *Explosive atmospheres — Explosion prevention and protection — Part 1: Basic concepts and methodology*

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 13023:2003+A1:2010, *Noise measurement methods for printing, paper converting, paper making machines and auxiliary equipment — Accuracy grades 2 and 3*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13849-1:2023, ISO 12100:2010 and the following apply.

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

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

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

3.1
actuator
part of a device to which an external action is to be applied

Note 1 to entry: The actuator can take the form of a handle, knob, pushbutton, roller, plunger, trip wire, pressure-sensitive mat, etc.

Note 2 to entry: There are some actuating means that do not require an external actuating force, but only an action; e.g. light beams. Such actuating means are not considered to be actuators.

Note 3 to entry: See also the definition for *machine actuator* (3.35).

3.2
armed condition
machine status in which machine motion can be automatically initiated

Note 1 to entry: *Zero speed* (3.87) is considered to be an armed condition.

3.3
audible alarm
horn, bell or other distinctive audible warning device that sounds to indicate impending machine motion

3.4
auxiliary device
mechanism or machine, either built-in or attached, used for the production process

Note 1 to entry: Examples for auxiliary devices are:

— continuous flow drying devices,

— pre-melter on a binder,

— gluers,

— perforating units,

— die cutters,

— numbering devices,

— imprinters,

— registration systems,

— prefolder,

— prefeeder,

— breakers (i.e. blank sheet separator), etc.

3.5
barrier guard
guard (3.24) that reduces or prevents physical access to a hazard zone by closing off access to an area containing one or more hazards

EXAMPLE A perimeter fence or tunnel guard.

3.6
binding and finishing system
combination of machines functioning in an integrated configuration to turn an incomplete printed product into a finished product by means of one or more processes, such as cutting, folding, binding, stitching, gluing, wrapping, etc.

3.7
bypass
temporary, time-limited suppression of one or more *safety functions* (3.64) through the use of safety-relevant parts of a control system

3.8
chucking cones
rotating parts of shaftless winding and unwinding devices, which are inserted into the ends of the core of the roll and enable the winding or unwinding of the roll of material

3.9
contact/pressure roller
<reel rewinding devices> driven or non-driven roller that is in contact with the material reel and is used to guide and ensure the winding hardness of the flat web that is to be rewound

3.10
continuous run
machine motion at a sustained speed until changed by the operator

3.11
control station
assembly of one or more control actuators that initiates or stops machine movement or potential of machine movement [torque at *zero speed* (3.87)], or places the machine in the *armed condition* (3.2)

3.12
control zone
control configuration of single or multiple machine motions using the same control devices

3.13
doctor blade
blade that wipes the excess (surface) ink from a gravure cylinder or anilox roller before printing or the excess coating from a cylinder during finishing operations

[SOURCE: ISO 12637-3:2009, 32]

3.14
drive
mechanism, divided into the following two general categories, which causes a machine or any of its elements to move:

— drives with no stored energy, such as direct-motor drives;

— drives having stored energy, such as motor-flywheel-clutch drives and hydraulic-pneumatic drives

3.15
electrical hazard
source of potential injury or death from electric shock or burn

3.16
electro-sensitive protective device
ESPD
assembly of devices and/or components working together for protective tripping or presence-sensing purposes (person, part of person, object) using non-contact detection means

Note 1 to entry: Light curtain, light beam, ultrasonic proximity sensor, vision-based protective devices, scanner, etc.

3.17
emergency stop command
change of signal state, the direct result of actuation of an *emergency stop device* (3.18)

3.18
emergency stop device
manually actuated control device used to initiate an *emergency stop function* (3.19)

[SOURCE: ISO 13850:2015, 3.3]

3.19
emergency stop function
safety function (3.64) initiated by a mechanism actuated by a single human motion and intended to halt machine activity in order to avoid injury to persons, damage to machinery or damage to work in progress

3.20
emergency stop pushbutton
emergency stop device (3.18) comprising an extended mushroom-head or palm-type actuator, positive opening contact element(s) and an engagement or latching-in feature

3.21
explosive atmosphere
mixture with air, under atmospheric conditions, of *combustible* (3.89) substances in the form of gas, vapour, or dust which, after ignition, permits self-sustaining propagation

[SOURCE: IEC 60079-0:2017, 3.38, modified — “flammable” substituted by “combustible”.]

3.22
exposing device
machinery used for creating images by exposing photo-sensitive material such as printing plates or printing formes

3.23
fixed guard
guard (3.24) that is securely affixed by fasteners that require a tool(s) to remove in order to gain access to an area with a *significant hazard* (3.68)

3.24
guard
physical barrier that restricts access to a *significant hazard* (3.68)

3.25
hazardous area
<explosive atmospheres> area in which an *explosive atmosphere* (3.21) is present, or can be expected to be present, in quantities such that special precautions for the construction, installation and use of equipment are required

Note 1 to entry: IEC 60079-10-1:2020 gives a classification of hazardous areas containing explosive gas atmospheres.

Note 2 to entry: IEC 60079-10-2:2015 gives a classification of hazardous areas containing explosive dust atmospheres.

Note 3 to entry: For the purposes of this document, an area is a three-dimensional region or space.

[SOURCE: IEC 60079-0:2017, 3.2, modified — Note 3 to entry has been added.]

3.26
hazard point
location of a hazard on a machine where a person can be injured

3.27
hazard zone
any area within and/or around machinery in which a person is exposed to risk of injury or damage to health

[SOURCE: ISO 12100:2010, 3.11, modified — "exposed to a hazard" has been substituted by "exposed to risk of injury or damage to health".]

3.28
hold-to-run control
control that starts and maintains machine motion only as long as the control is activated

Note 1 to entry: Hold-to-run control, in some countries, is known as inching/jogging (not necessarily related to measurement).

3.29
inch
jog
<operation of machinery> machine motion requiring maintained activation engagement of a *hold-to-run control* (3.28) and which will continue, until the control is released, at a limited maximum operating speed or until a pre-determined displacement has been reached

3.30
infrequently used working area
area in which an activity is carried out, such as observation, *make-ready* (3.38), jam clearing, minor servicing, crossing inserting hoppers or conveyer belts, etc., that is routine, repetitive, integral to (but not necessarily during) production, and is done only on an occasional basis

3.31
irreversible injury
injury leading to severe permanent health damage or at least 6 months functional impairment

[SOURCE: Decision 2010/15/EU[62]]

3.32
disabling injury
injury leading to loss of limbs or death or disability >10 %

[SOURCE: Decision 2010/15/EU[62]]

3.33
in-running nip
in-going nip
area created either by two rotating components that are rotating inward, or by one component rotating toward an adjacent surface

Note 1 to entry: See Figure 4 for examples of in-running nips.

3.34
interlock
⟨for safeguarding⟩ arrangement that interconnects guard(s) or device(s) with the control system and/or all or part of the electrical energy distributed to the machine

3.35
machine actuator
power mechanism of the machine used to effect motion (for example, motor, solenoid, pneumatic or hydraulic cylinder)

[SOURCE: IEC 60204-1:2016+AMD1:2021, 3.1.39]

3.36
maintained-contact control
control that remains in an open or closed state after its activation

3.37
maintenance
operation required to ensure that the machine remains in acceptable operating condition and that is usually performed when the machine is not available for production

Note 1 to entry: Maintenance (for example, repairing or replacing broken, worn or damaged parts; performing lubrication; preventive servicing) is performed by qualified maintenance personnel, or operators, who have been trained about the types of hazards in the area in which their tasks are to be performed and about how these hazards can be avoided. Such maintenance is performed with energy isolated, when possible.

3.38
make-ready
task preceding a production run, such as adjusting ink controls for proper colour, plate alignment for proper registration, adjusting pressures, measurement with quality control devices, etc.

3.39
manual control device
mechanism comprising part of the actuating system to which a manual action is applied

3.40
manually fed
feeding of material where substrate is placed into and/or removed from the machine by hand

3.41
mechanical hazard
hazard that could result in injury to a person created by motion of machinery, components or material

EXAMPLE Crushing and shearing points; trapping points; *in-running nips* (3.33); cutting, punching and impact points; gear, chain and worm drives; V-belt, flat belt, cord and rope drives; pulling and supporting elements on continuous conveyors; spoke wheels and fly wheels; shafts and shaft ends; rollers; slides; push rods and similar parts, tools and clamping devices.

3.42
momentary-contact control
control that is opened or closed only during its actuation

3.43
motion zone
area defined by any machine component, or group of machine components, which is driven directly by the system drive motor(s) or *machine actuator(s)* (3.35), or indirectly by other means

3.44
movable guard
guard (3.24) that does not require a tool to move or remove it to gain access to a *significant hazard* (3.68)

3.45
nip guard
guard (3.24) located at an *in-going nip* (3.33)

EXAMPLE Nip bar, finger bar, finger guard.

3.46
normal operation
functions and conditions that usually exist during set-up, *make-ready* (3.38), production and minor servicing, adjusting and cleaning performed by operators, but not including *maintenance* (3.37) operations

3.47
operating position
location where normal functions (make-ready and other routine, repetitive tasks) requiring control of the main drive motor(s) are performed

3.48
permissive period
time interval during which machine motion can be initiated

3.49
personnel warning light
red or green light used to indicate the ready, running and *safe conditions* (3.62) of the machine relative to personnel safety

Note 1 to entry: These lights are not the same as *machine status light* (3.71).

3.50
portable control station
control device (not in a fixed position) that transmits signals using a cableless system or flexible cord

Note 1 to entry: The cord can be permanently connected or plugged-in.

3.51
positive opening
contact separation as the direct result of a specified movement of the *actuator* (3.1) through non-resilient members, such as those not dependent on springs

3.52
raised workplace
area where functions are regularly performed, and are at least 0,5 m above access level

3.53
ready condition
status of a machine in which motion can be initiated by the operator

3.54
reel rewinding device
reel rewinding unit
part of a machine used for rewinding the processed web-type material

3.55
reel rewinding devices with automatic reel change
devices for changing the web from the (full) material reel to a new material reel (core) for rewinding that is carried out in an automated reel changing unit, e.g. in the form of a high-speed impact cutting process

Note 1 to entry: The web is continuously fed to the automatic reel rewinding device.

3.56
reel rewinding devices with manual reel change
devices for changing the web from the (full) material reel to the new material reel (core) for rewinding that is carried out manually while the material reel stands still

3.57
reel stand
equipment which allow the winding or unwinding of the material

3.58
reel unwinding device
reel unwinding unit
part of a machine used for unrolling web-type material for processing

3.59
remote access
connection to the processor of a machine for the purpose of conducting diagnostics, data extraction, software updates, etc. from either a local or remote location

3.60
residual pile monitoring system
device that monitors the feed stack to detect when it gets close to being empty

3.61
routine and regular access
repetitive access to a *hazard point* (3.26) that is required during normal production activity

3.62
safe condition
machine status in which movement which is likely to cause injury is prevented, which can apply to the entire machine or to one or more motion zones, and which exists only when one or more *stop/safe pushbuttons* (3.74) is/are actuated or *emergency stop device(s)* (3.18) also meeting the criteria of stop/safe pushbutton(s) is/are actuated

3.63
safety distance
minimum distance a protective device is required to be placed from a *hazard zone* (3.27)

[SOURCE: ISO 13857:2019, 3.2]

3.64
safety function
function of a machine whose failure can result in an immediate increase of risk(s)

[SOURCE: ISO 12100:2010, 3.30]

3.65
separating element
part on feeders of sheets, blanks or similar materials that separates the individual sheets, blanks

3.66
sheet-fed
material supply, in which the substrate is fed in separate sheets, either manually or mechanically

3.67
side lays
assembly with adjustable side stoppers on which incoming sheets are aligned laterally

3.68
significant hazard
hazard that could result in *irreversible injuries* (3.31) or *disabling injuries* (3.32) or death

3.69
smooth cylinder
smooth roller
elongated body, solid or hollow, with a circular cross-section having a smooth surface with either of the following:

a) grooves no more than 4 mm deep (measured in the radial direction) and no more than 8 mm wide (measured in the circumferential direction), with no sharp or cutting edges (see Figure 1); or

b) grooves no more than 4 mm wide (measured in the circumferential direction), with no sharp or cutting edges

Note 1 to entry: "Cylinders" includes plate cylinders, blanket cylinders, impression cylinders, etc. Ink rollers, dampening water rollers or distribution drums are not considered to be cylinders as defined in this document.

Dimensions in millimetres

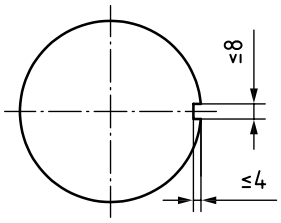


Figure 1 — Smooth roller/cylinder

3.70
splicer
machine which cut processed material and join (splice) new material together

3.71
machine status light
light that indicates machine status or machine process condition

Note 1 to entry: Status lights are not the same as *personnel warning lights* (3.49).

3.72
stop control device
manually actuated control intended to stop machine motion during *normal operation* (3.46)

3.73
stop/safe function
safety function (3.64) initiated by a mechanism actuated by a single human motion and intended to halt machine activity in order to avoid injury to persons, damage to machinery or damage to work in progress and to place the machine in a *safe condition* (3.62)

3.74
stop/safe pushbutton
manually actuated control used to initiate a *stop/safe function* (3.73) and comprised of an extended mushroom-head or palm-type actuator, positive opening contact element(s) and engagement or latching-in feature

3.75
substrate
material on which the process is conducted

EXAMPLE Board, corrugated board, plastic film, aluminium foil, sheet metal and photographic paper

Note 1 to entry: The process can refer to printing, laminating, varnishing, etc.

3.76
support roller
bearer drum
driven or non-driven rollers used to drive or support the material reel

Note 1 to entry: As a rule, support rollers/bearer drums are under the rewinding roll.

3.77
tool
implement, such as a key (e.g. double bit key, three-square socket key, square socket key) or wrench, designed to operate a fastener

Note 1 to entry: An item such as a coin or fingernail file is not considered to be a tool.

3.78
touch-sensitive control device
TSCD
electronic input device, controlled by touching, lifting off or moving across a sensitive surface or display with one or more fingers or a stylus/pen, whose actuation generates a position and/or selection signal

EXAMPLE Touchpads, touchscreens, digitalization boards.

Note 1 to entry: In contrast to contact-based operating elements (switches, push buttons) reliable generation of the operating signals by the TSCD depends on the dedicated software and hardware used in the TSCD. Furthermore, the control points are not at a fixed position and cannot be felt.

3.79
trip device
protective device where actuation initiates the stopping action

3.80
trip nip bar
movable protective bar located at an in-running nip which, when actuated, initiates stopping action

3.81
troubleshooting
procedure for rectifying of operational failures, such as clearing blockages

3.82
two-hand control
safety device that consists of two *manual control devices* (3.39) which requires simultaneous actuation by a single operator to initiate potentially hazardous machine motion

3.83
unit
device
part of a larger machine with a specific function or purpose

Note 1 to entry: These terms can be used interchangeably for processes related to press equipment and systems

3.84
warning period
time interval during which machine motion is prevented and a warning is given to personnel that machine motion is about to occur

3.85
web-fed
material supply, in which the substrate is fed from a roll or a pack of continuous stock

3.86
cableless motion control
wireless control
transmission of commands and signals between a machine-control system and the control station(s) using means other than a physical connection

EXAMPLE Radio, infra-red.

3.87
zero speed
condition of machine movement in which the drive control system is actively holding the machine at a position and while machine movement is not discernible, machine movement can be initiated without warning

Note 1 to entry: Zero speed is considered to be an *armed condition* (3.2).

3.88
glow temperature
minimum ignition temperature of a dust layer or a dust cloud

3.89
combustible
capable of being ignited and burned

[SOURCE: ISO 13943:2017, 3.52]

3.90
flammable
capable of *flaming combustion* (3.91) under specified conditions

[SOURCE: ISO 13943:2017, 3.180]

3.91
flaming combustion
combustion in the gaseous phase, usually with emission of light

[SOURCE: ISO 13943:2017, 3.52]

3.92
zone
<explosive atmospheres> *hazardous areas* (3.25) classified into zones based upon then frequency of the occurrence and the duration of an *explosive atmosphere* (3.21)

[SOURCE: IEC 60079-14:2013, 3.2.6]

3.93
service temperature
maximum or minimum temperature reached at specific points of the equipment when the equipment is operating at rated conditions, including ambient temperature and any external sources of heating or cooling

Note 1 to entry: Equipment can reach different service temperatures in different parts.

[SOURCE: ISO 80079-36:2016, 3.8, modified — The symbol T_s has been omitted.]

4 Significant hazards

For the list of significant hazards covered by this document, see Annex B.

5 Safety requirements and/or protective measures

5.1 General

Machinery shall be in accordance with the safety requirements and/or protective measures of this subclause. In addition, machinery shall be designed according to the principles of ISO 12100:2010 for relevant but not significant hazards that are not dealt with by this document (e.g. sharp edges of the machine frame). Safe reach distances shall be in accordance with ISO 13857:2019.

5.2 Risk assessment

Risk assessment on machinery covered by the ISO 12643 series shall be conducted in accordance with ISO 12100:2010.

5.3 Safeguarding of significant hazards

5.3.1 General principles

Machinery shall be designed using the risk assessment process and principles of ISO 12100:2010 for hazards, and the relevant parts of ISO 12643 for machine-specific hazards. In accordance with the risk assessment, guarding that is appropriate to the level of risk shall be provided to prevent persons being exposed to significant hazards. The selection of guarding should be chosen in accordance with ISO 14120:2015. Exposure to significant hazards is not considered to exist if, during normal operation, the distance to the hazard complies with those specified in ISO 13857:2019.

Machines should be designed to allow normal production operations such as make-ready, wash-up, operator-performed maintenance or troubleshooting without machine motion.

Where machine motion is required to perform these functions, guards and safety protective devices shall provide protection against hazards. These operations shall be carried out using a hold-to-run device as specified in this document, and specified in the requirements for hold-to-run controls defined in the subsequent parts of the ISO 12643 series for prepress and press equipment and systems, for binding and finishing equipment and systems, for converting equipment and systems, or for stand-alone platen presses.

Where moving components or product flow require surveillance, equipment shall be designed to allow the needed visibility and to allow adjustments, if needed, to equipment operation with the guards remaining closed.

EXAMPLE A transparent guard or remote viewing system.

Hazards for crushing of parts of the human body are not considered to exist if the minimum distances as specified in ISO 13854:2017 are maintained or exceeded.

5.3.2 Guards

5.3.2.1 Guard types and travel

5.3.2.1.1 Types of guards

For the purpose of this document, there are two types of guards, fixed and movable.

NOTE 1 Due to ergonomic principles a fixed guard can be hinged and not interlocked.

When fixed guards are used and it is foreseeable that they will be removed particularly when performing maintenance, adjustment, setting, their fastenings shall remain attached to the guard or to the machinery when the guard is removed.

EXAMPLE See Figure 2 and ISO 14120:2015, Annex A.

Rotary clamping closures are suitable when they are either to be opened with a tool or are provided with a lockable handle.

This requirement does not necessarily apply to fixed guards that are only liable to be removed for example, when the machine is completely overhauled, is subject to major repairs or is dismantled for transfer to another site.

All movable guards shall be interlocked in accordance with 5.3.5.

Guards that are designed to be opened, removed, and/or moved at least once per working shift (typically 8 h) during normal operation or for set-up purposes with or without the use of a tool, shall be interlocked.

NOTE 2 Guards and doors are removed for "set-up" purposes, for example:

— to supply the material to be processed;

— to change the size;

— to change tools;

— for make-ready;

— for washing-up.

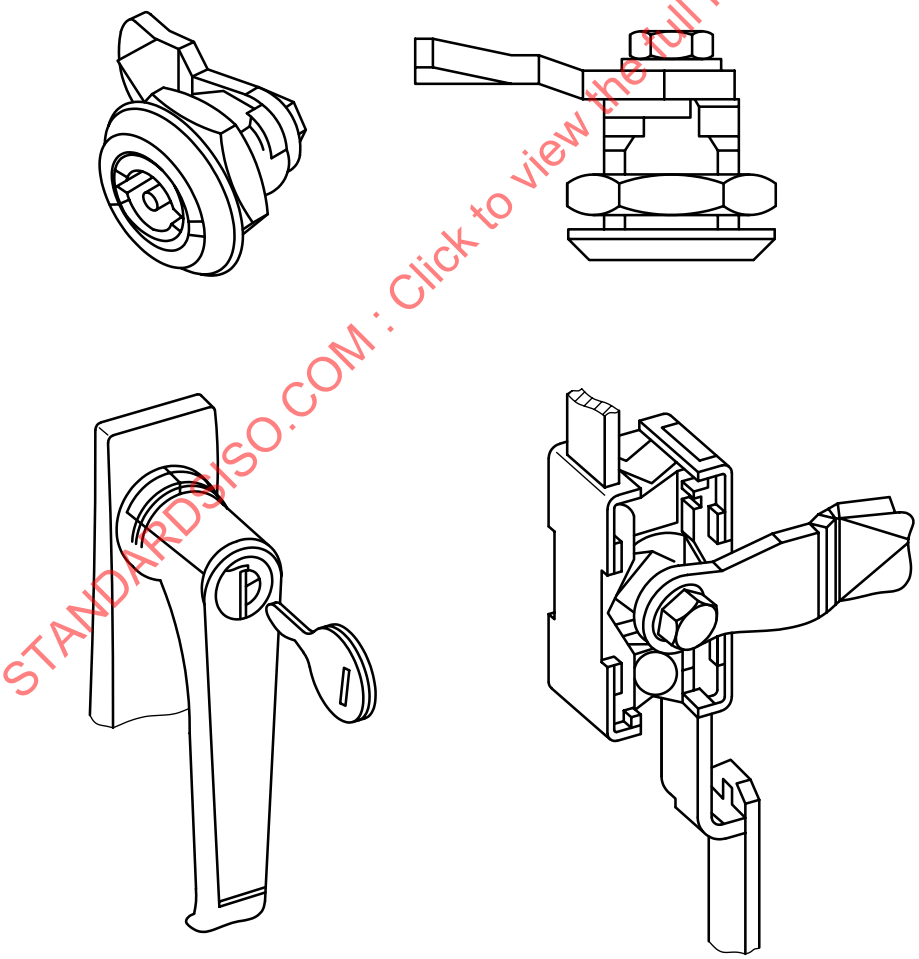


Figure 2 — Examples of a retained fastening

The interlock system shall operate as described in 5.3.5.1.

When the interlocking guard is open, one of the measures set out in 5.3.6 shall become effective.

Where production processes need to be watched, guards shall be designed to ensure sufficient visibility of the functional process and not to impair vision by reflections.

EXAMPLE Mesh-type guards painted in matte black, placement of lighting behind the guard, etc.

Guards shall not create any additional significant hazards to personnel and shall satisfy the requirements of ISO 14120:2015 and ISO 14119:2013.

5.3.2.1.2 Power-driven travel of movable guards

For the safeguarding of power-driven travel of movable guards, see 5.4.16.1.

5.3.2.1.3 Protection against gravity falls of guards

Guards that can be opened shall be safeguarded against gravity falls if such a fall creates a risk of injury.

EXAMPLE The following are examples of means that can be used for safeguarding:

— devices for balancing the mass;

— pneumatic springs;

— devices which automatically hold the parts open;

— power-driven worm gear drives actuated by hold-to-run controls if the hazard points can be observed from the position where the hold-to-run control is actuated;

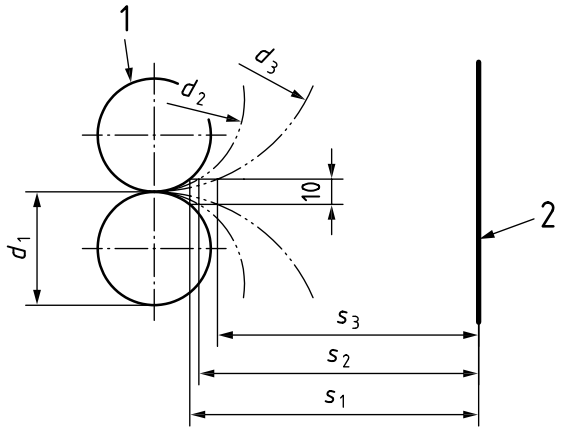
— ensuring that the centre of gravity of the guard in the open position is sufficiently far behind the axis of rotation to prevent closing.

Springs used for balancing the mass shall be designed such that no hazard shall result from failure of the spring or movement of the guard. Compression-type springs are preferred. Springs shall not display any permanent deformation, even after extensive use.

5.3.2.2 Guard dimensioning, positioning and safety distances

The design and construction of the barrier guard shall ensure that personnel cannot encounter the hazard by reaching up, over, under, around or through the fixed guard. This is achieved by being in accordance with the requirements of ISO 13857:2019.

Dimensions in millimetres



Key

1	rolls with different diameters
2	guard
d_1, d_2, d_3	three different diameters
s_1, s_2, s_3	related safety distances

Figure 3 — Measuring safety distance at the in-running nips

When using general guarding rather than nip guarding (see 5.3.4.) then safety distances from guards to in-running nips shall be as specified in ISO 13857:2019.

The safety distance according to ISO 13857:2019 is measured at that point where the distance between the rotating surfaces, or the rotating surface and a fixed surface, is 10 mm (see Figure 3).

5.3.2.3 Guard openings

Guard openings shall be in accordance with the requirements of ISO 13857:2019. For guarding in-running nips that are accessible while a movable guard is open, see 5.3.4 and/or 5.3.6.

5.3.3 In-running (in-going) nips

Hazards from in-running nips exist, for example, between the following:

a) two counter-rotating surfaces, powered or non-powered;

NOTE 1 An example of a non-powered surface is a roller that is driven by movement of product. For non-powered surfaces, this hazard depends on a number of factors (e.g. type of material, wrapping angle, inertia, etc.).

b) one surface rotating toward an adjacent fixed part of the machine;

c) surfaces rotating in the same direction, but with different peripheral speeds;

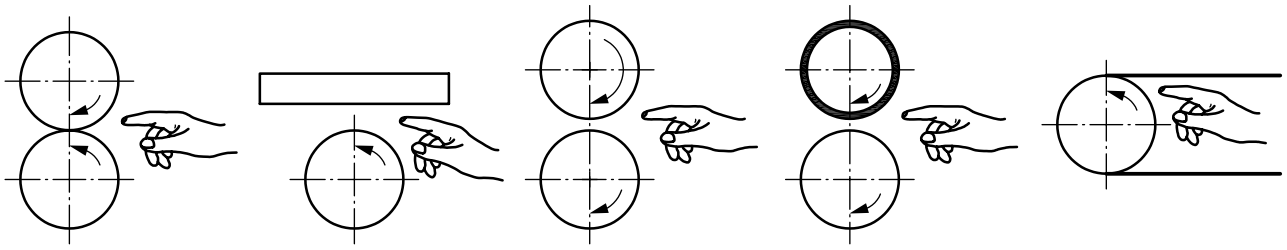
d) surfaces rotating in the same direction, but with different surface properties, such as friction;

NOTE 2 Rollers rotating in the same direction do not create a hazardous in-running nip if the rollers have the same surface characteristics and same circumferential speeds.

e) guide roller and driving belt, conveyor belt, and unwind/rewind devices;

f) non-powered riding rollers (guide rollers) that are driven by the movement of the product (see NOTE 1).

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



a) Two counter- rotating rolls | **b) One rotating roll and an adjacent fixed object** | **c) Two rolls rotating in the same direction at different speeds** | **d) Two rolls rotating in the same direction, but with different surface properties (friction)** | **e) Belt, chain or web which is driving, or being driven by, a roll**

Figure 4 — In-running nips

5.3.4 Guarding in-running nips

All in-running nips that are accessible during normal operation shall be guarded by one or more of the following types of guards:

a) barrier guard or fence guard with or without openings; if the guard has an opening, the safety distances shall be established in relation to the width of the opening in accordance with Table 1;

b) nip guards, (only allowed on smooth rollers/cylinders), designed in suitable sections and extending across the entire working width (see Figure 5 for examples of nip guards and Figure 8 of unacceptable types of nip guards); and

c) trip nip bars shall be in accordance with 5.7.7.

In-running nips created by rollers are not considered to be a significant hazard if the maximum draw-in force exerted does not exceed 50 N.

When machine motion is reversed, out-going nips that do not generally pose a hazard can become in-running nips and shall be guarded as such.

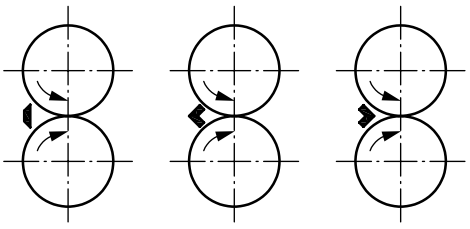
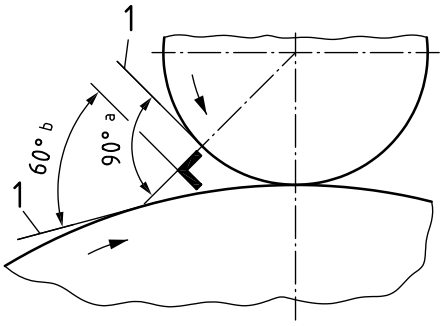


Figure 5 — Examples of nip guards

Whenever possible, the angle between the surface of the cylinder and the surface of the guard should be 90° to prevent wedging. However, if other design considerations, such as stiffness of the guard, web path, etc., make the use of a 90° angle less desirable, an angle of not less than 60° is permitted (see Figure 6).



Key

1 tangent

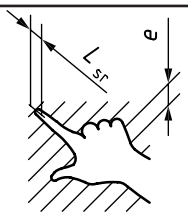
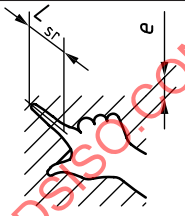
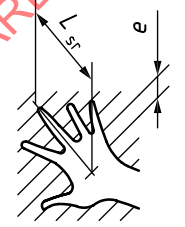
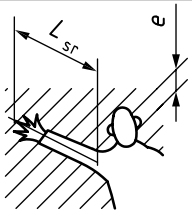
[a] Preferred.

[b] Acceptable.

Figure 6 — Minimum cylinder-to-guard angle

Table 1 — Safety distances, L_{sr}, for regular openings for persons 14 years of age and above

Dimensions in millimetres

Part of body	Illustration	Opening	Safety distance L_{sr}		
			Slot	Square	Round
Finger tip		$e \leq 4$	≥2	≥2	≥2
		$4 < e \leq 6$	≥10	≥5	≥5
Finger up to knuckle joint or hand		$6 < e \leq 8$	≥20	≥15	≥5
		$8 < e \leq 10$	≥80	≥25	≥20
		$10 < e \leq 12$	≥100	≥80	≥80
		$12 < e \leq 20$	≥120	≥120	≥120
		$20 < e \leq 30$	≥850[a]	≥120	≥120
Arm up to junction with shoulder		$30 < e \leq 40$	≥850	≥200	≥120
		$40 < e \leq 120$	≥850	≥850	≥850

NOTE The dimensions of openings e correspond to the side of a square opening, the diameter of a round opening and the narrowest dimension of a slot opening.

[a] If the length of the slot opening is ≤ 65 mm, the thumb will act as a stop and the safety distance may be reduced to 200 mm.

The clearance between the nip guard and the respective machine part shall not exceed 6 mm under its normal operating configuration (for example, plate or blanket installed on the cylinder, if applicable) (see Figure 7). On small-format machines, the clearance should be smaller, if possible, considering both safety and production concerns.

Dimensions in millimetres

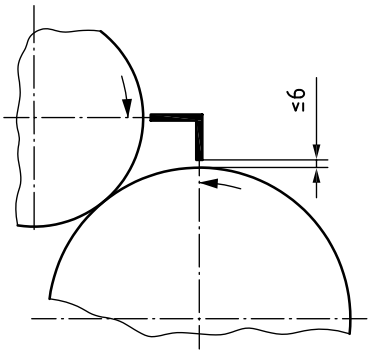
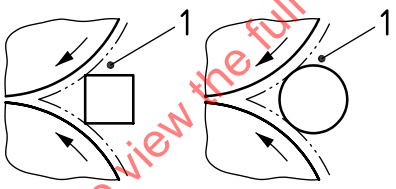


Figure 7 — Safeguarding an in-running nip by means of a fixed nip guard

Nip guards shall not be shaped or oriented such that a "wedge pocket" is created (see Figure 8). The shapes shown in Figure 8 may be used as trip nip bars, since activation of the trip nip bar stops hazardous motion, as specified in 5.7.7.



Key

1 wedge pocket

Figure 8 — Shapes creating wedge pockets (only permissible as trip nip bars)

The in-running nips between guide rollers and between guide rollers and fixed machine parts shall be safeguarded by providing a minimum separation of 120 mm, or by fixed or interlocking guards.

Smooth powered rollers whose surfaces are 120 mm or greater apart are not nip hazards where whole body or head access to the hazard zone is not likely.

Smooth non-powered guide rollers whose surfaces are 75 mm or greater apart are not nip hazards where whole body or head access to the hazard zone is not likely.

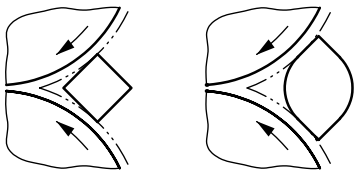


Figure 9 — Shapes not creating wedge pockets

5.3.5 Interlocks

5.3.5.1 Opening an interlocking guard

When an interlocking guard is opened, moved or removed machine motion shall be stopped without creating additional significant hazards, utilizing the maximum braking action established for that machine. When any interlocking guard is open, starting of the machine shall be prevented. Closing or reinsertion of an interlocking guard shall not cause the machine to restart its operation. Machine motion shall not be able to be initiated without the operator going through a normal starting sequence.

The following exceptions are possible.

— If a machine is operating at inching speed and under the conditions defined in 5.3.6, motion may continue.

— If a machine is running at a maximum (surface) operating speed of 5 m/min with continuous run and hazards are limited to in-running nips which are guarded with trip guards, motion may continue. Interlocking guards can be open in more than one zone.

5.3.5.2 More than one interlocking guard open

Where more than one interlocking guard is open and there are any unguarded hazard within the zones that cannot be observed from all operating positions, only an inch function or reverse inch function (as specified in 5.7.2.5.5) shall be permitted if

a) all in-running cylinder nips behind interlocking guards are additionally guarded by nip guards and all other hazards are guarded; or

b) multiple operators depress and maintain a hold-to-run control at each unguarded area during the same permissive period. Releasing any hold-to-run control shall stop machine motion.

5.3.5.3 Interlock design

5.3.5.3.1 Interlock design for personnel safety

Interlocks shall be designed so that they cannot be overridden without the use of special tools.

NOTE While it is recognized that all interlocking schemes are capable of being defeated, the intent of the above requirement is to ensure that the interlocking arrangement is designed in such a manner that it cannot be defeated by commonly available items such as tape, paper, a single common magnet, etc., which are not considered to be tools.

The requirements of ISO 14119:2013, Clauses 5 and 6, shall be satisfied. For the purposes of this document "permanently fixing", as stated in ISO 14119:2013 7.2 c), allows the use of special fasteners and the addition of sealing materials. Examples of solutions include:

— round-head internal hexagon screws which require a special tool, and

— pop rivets.

5.3.5.3.2 Safety-position switches for interlocking guards

Safety-position switches shall be built in accordance with IEC 60947-5-1:2016+COR1:2016 and IEC 60947-5-3:2013, and shall be installed in accordance with IEC 60204-1:2016+AMD1:2021.

For machines where routine and regular access to a hazard zone is not required, it is sufficient to provide only one safety-position switch for each interlocking guard.

NOTE A single switch is adequate because it is assumed that no safety-related malfunction will occur in switches built and installed to the specified requirements.

The signal processing of the safety position switches for interlocking guards shall meet at least the PL according to ISO 13849-1:2023 for the safety related parts of the control system required for the safety function. See 5.10.1.2

5.3.5.3.3 Protection of electric wires outside the switch cabinet

Short circuits between two electric wires outside the switch cabinet due to physical impacts shall be prevented by mechanical protection of the cable.

See 5.3.5.3.2 and 5.10.1 for requirements relating to design of safety-related parts of an electric/electronic control system.

EXAMPLE Locating wires within ducts or within the machine frame to protect them from impact.

5.3.6 Hold-to-run mode

Where hold-to-run controls are used for safeguarding a hazard, running the machine in the hold-to-run mode after opening the interlocking guard shall be possible only when guards protecting hazard zones that are not visible from the operating position are closed.

When the hazard zone can be viewed from the operating position, machine motion with an interlocking guard open and hazardous points unprotected may be initiated by means of a hold-to-run device under one of the following conditions:

a) with a displacement limited to a maximum of 25 mm or with a maximum operating (surface) speed of 1 m/min; or

b) with displacement limited to a maximum of 75 mm or with a maximum operating speed of 5 m/min where the measures defined in a) would reduce the ability of the machine to perform its function and where there would be no substantial increase in risk.

Safety related parts of control systems of interlocking guard systems for the safety reduced speed/displacement limited condition shall be in accordance with at least PL d of ISO 13849-1:2023 or SIL 2 of IEC 62061:2021. Safety related control systems (including selector switches relays and PLC circuits) that allow interlocked areas to be operated independently shall be in accordance with at least PL b of ISO 13849-1:2023 or SIL 1 of IEC 62061:2021.

Provided that safe speed reduction or limitation of displacement in accordance with PL d of ISO 13849-1:2023 is ensured, the signal release for starting in hold-to-run mode or stopping may be effected by one single contact, if the further processing of signals of the hold-to-run switch/contact is done in accordance with PL d of ISO 13849-1:2023.

Higher displacement or speeds may be possible with a two-hand control based on a task-based risk assessment demonstrating that acceptable risk has been achieved.

Where speeds are greater than 5 m/min, then the maximum speed shall be kept as low as possible and no faster than 10 m/min as long as either a two-hand control is used, or the control is located such that the hazard cannot be reached from the operating position. Any speed greater than 10 m/min shall have a means of achieving a level of safety equivalent to that at 10 m/min unless an exception to this requirement is specified in the requirements for hold-to-run controls.

Any exception to this requirement can be specified in the machine-specific parts of the ISO 12643 series. The hold-to-run speed shall be the slowest possible under procedural requirements.

Any two-hand control device shall meet the requirements specified in 5.7.5. The stopping time shall be as short as technically feasible.

See 5.10.1 for general requirements for control systems.

5.3.7 Protective measures for accessible hazard zones

5.3.7.1 General

Where safeguarded accessible hazard zones cannot be observed from positions from which hazardous movements can be started, the requirements of 5.3.7.2 to 5.3.7.4, shall apply.

5.3.7.2 Fence-type enclosures

Where accessible hazard zones are safeguarded by a fence-type enclosure, either:

a) it shall not be possible for one or more persons within the enclosure to close the interlocking access gate; or

b) an additional control device shall be provided outside the enclosure in such a position that it cannot be actuated from the inside. Any hazardous movement, with the exception of movement controlled by hold-to-run, shall be permitted only after the access door has been closed and the additional control device has been actuated.

EXAMPLE Additional control devices include reset buttons, captured keys, trapped keys, and similar devices.

Fence-type enclosures shall be designed such that the distance between base level and the lower edge is a maximum of 200 mm, and between base level and the upper edge is a minimum of 1 400 mm. Safety distance requirements shall be in accordance with ISO 13857:2019.

NOTE Fence-type enclosures are often used in areas such as behind reel stands, automatic pile changers, etc.

5.3.7.3 Electro-sensitive protective devices

Where accessible hazard zones are safeguarded by means of electro-sensitive protective devices (ESPDs), an additional control device shall be provided outside the hazard zone and shall not be accessible from any position in the hazard zone. Provisions shall be made to ensure that the hazardous movement can only be started after the person has actuated the additional control devices.

NOTE For example, accessible safeguarded hazard zones are areas generally protected by means of guards or electro-sensitive protective devices that allow whole-body access. The objective is to prevent anyone from starting the machine while a person is within the hazard zone.

Electro-sensitive protective devices shall be in accordance with 5.7.6.

5.3.7.4 Pressure-sensitive mats, pressure-sensitive bumpers, trip nip bars

Pressure-sensitive mats, pressure-sensitive bumpers and trip nip bars shall function in accordance with 5.7.7.

Where accessible hazard zones are safeguarded by means of pressure-sensitive mats, an additional control element that is not accessible from any position in the hazard zone shall be provided outside the hazard zone. Any hazardous movement, with the exception of movement controlled by hold-to-run, shall be permitted only after the additional control device has been re-actuated.

EXAMPLE An example of an additional control device is a reset button.

For safety-related applications, the approach speed specified in ISO 13855:2010 shall be used as a basis for determining the correct positioning of the pressure-sensitive mats.

5.3.7.5 Auxiliary devices that act as guards

Auxiliary devices (see 3.4) that act as guards to prevent access to hazard points in the built-in position shall be fitted so that they can be removed only by means of tools. Auxiliary devices that prevent access

to hazard zones, and that need to be removed frequently or accessed for set-up, act as movable guards and shall be interlocked with any hazardous movement (see 5.3.5).

NOTE For example, auxiliary devices that prevent access to hazard points in their built-in position might be continuous flow drying devices on the delivery side of sheet offset printing presses where drying modules are inserted into the printing press from the side that, when removed, allow access to hazard points on the sheet gripper system. A pre-melter on a binder is another example of an auxiliary device that prevents access to the hazard point.

When the machine is operated with the auxiliary device removed, thereby exposing a hazard, alternative guards shall be used to protect the hazard point(s).

5.3.8 Guarding reel unwinding, rewinding and transport devices

5.3.8.1 Hazard point between reel and belt

On unwinding and rewinding devices where the reel is driven by a belt on the reel circumference (see Figure 10), the hazard point between the reel and the belt shall be safeguarded if the force between belt and reel is more than 300 N.

EXAMPLE This can be achieved by the use of interlocking guards or fence-type enclosures.

Safeguarding can also be required for force less than or equal to 300 N if a hazard is created by the speed of the machine.

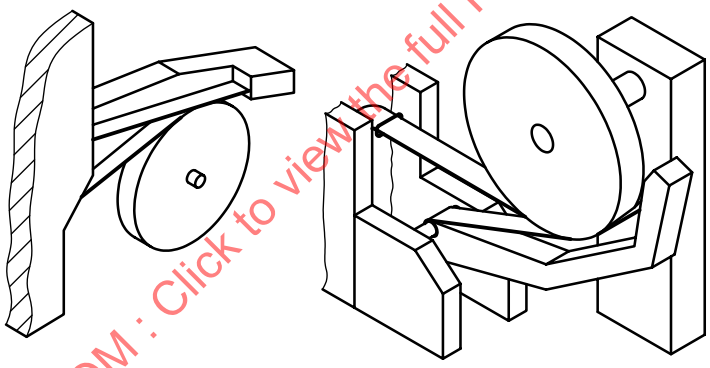


Figure 10 — Belt drives

Guards shall be provided for protecting the in-running nips on the drive belt guide rollers (see Figure 11).

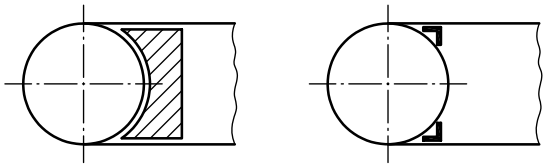


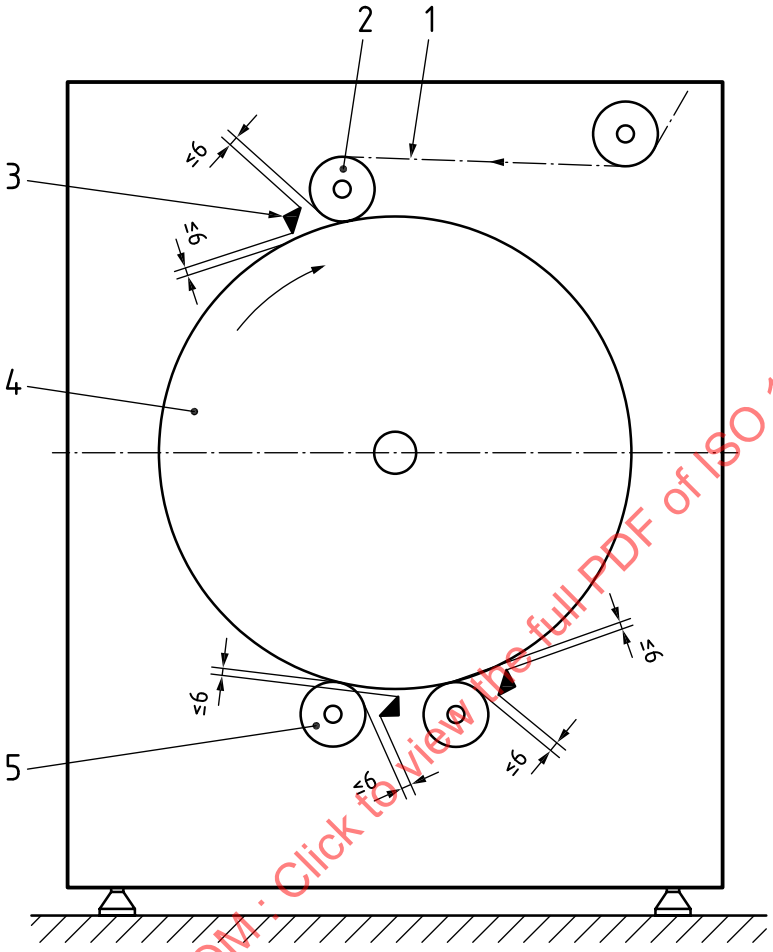
Figure 11 — Examples of safeguarding of belt in-running nips on belt drives

5.3.8.2 Drawing-in nips at reel unwinding and rewinding devices with support rollers or bearer drums

On unwinding and rewinding devices, the in-running nips between material reel, and support rollers shall be safeguarded (see 5.3.4) by means of guards or safety devices having approach reaction [trip devices, pressure-sensitive mats, electro-sensitive protective devices (ESPDs)]. The safety device selected shall be effective for all reel diameters. Access to the in-running nip from the side shall not be possible.

In-running nips created by rollers are not considered to be a significant hazard if the maximum force exerted does not exceed 150 N.

For trip devices and pressure-sensitive mats, see 5.3.7.4 and 5.7.7. For electro-sensitive protective devices (ESPDs), see 5.3.7.3 and 5.7.6.



Key

1 web
2 pressure roller
3 protective profile
4 driven material reel
5 bearer drum

Figure 12 — Example of a bearer drum roller with safeguards

5.3.8.3 Requirements for chucking cones for manual reel loading and unloading

Where shaftless unwinding or rewinding is used, the chucking cones in the loading and unloading area (see Figure 13) shall be designed so that they can be inserted only in the hold-to-run control mode. Control devices shall be arranged such that hazard points between chucking cones and reel can be observed from the position of the hold-to-run control allocated to the unwinding and rewinding unit. The hold-to-run speed of in/out motion of the chucking cones shall not exceed 5 m/min (see 5.3.6 b).

When the reel is lifted up or moved from the loading and unloading area, the opening of the chucking cones shall not create a hazardous situation, such as crushing the upper body or other irreversible injuries by a reel falling out from the chucks. Therefore, the following is required:

— If the only safety measure is a control system it shall be in accordance with at least PL d of ISO 13849-1:2023 or SIL 2 of IEC 62061:2021; or

— If one or more of the following conditions are met, the control system shall be in accordance with at least PL b of ISO 13849-1:2023 or SIL 1 of IEC 62061:2021:

  — the roll weight is maximum 25 kg;

  — the roll is raised maximum 150 mm from the floor;

— If all of the following conditions are met, the control system shall be in accordance with at least PL c of ISO 13849-1:2023 or SIL 1 of IEC 62061:2021:

  — the distance between full roll and access floor level is a minimum of 180 mm;

  — the shaft is a maximum of 700 mm above access floor level;

  — web speed: lower than or equal to 3 m/s; and

  — roll width up to 520 mm.

The position of the chucking cones in the loading and unloading area shall be monitored to prevent unsafe movement. In cases that could create a hazardous situation, for example crushing the upper body or other irreversible injuries and the only safety measure is a control system, it shall be in accordance with at least PL d of ISO 13849-1:2023 or SIL 2 of IEC 62061:2021.

NOTE 1 With manual reel-loading, the control system check that the full insertion of the chucking cones into the roll takes place within the machine-specific loading and unloading area (see Figure 13, item 4).

For automatic reel-loading, see 5.3.8.10.1.

Provisions shall be made to ensure that shaftless unwinding and rewinding units can be started only after the chucking cones are fully inserted.

NOTE 2 This is ensured, for example, by monitoring the position of the chucking cones by means of sensors.

NOTE 3 For example, this can be accomplished for manually operated machines by providing the operator with a clear view of the chucking cones using mirrors or a video monitor. For fully automatic machines, this can be accomplished by using a pressure-sensing monitor.

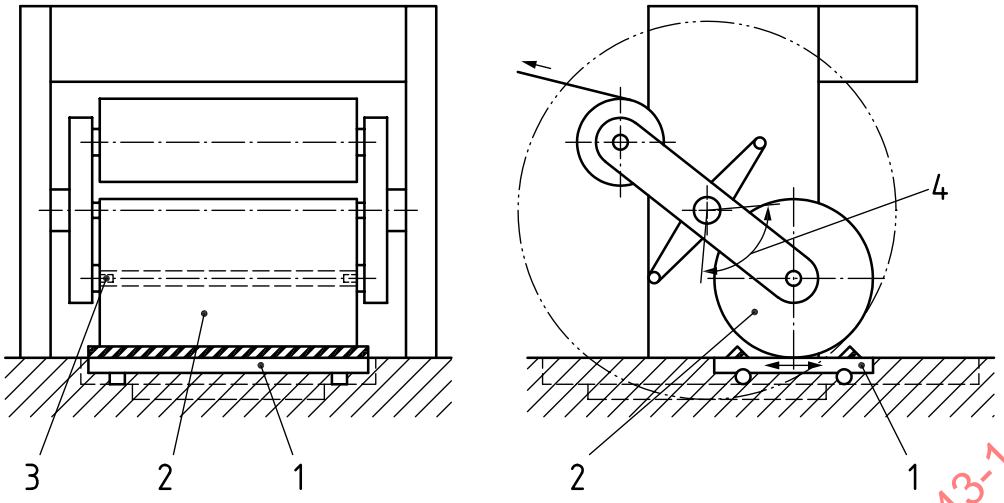
Where the position of the chucking cones is monitored by sensors, it shall meet the requirements of 5.10.1.2. The return movement of the reel core removing device shall not cause any crushing hazard points with the lifting arms. Safeguarding shall be achieved by:

— limiting the return movement to a speed of 0,5 m/min,

— limiting the force to 150 N, or

— limiting speed to 5 m/min in hold-to-run operation.

Higher speeds in hold-to-run operation shall only be possible with two-hand control.



Key

1 transfer table
2 new material reel
3 chucking cone
4 machine-specific loading and unloading area

Figure 13 — Loading and unloading area

5.3.8.4 Prevention of ejection of material reels (residual reel)

On shaftless unwinding and rewinding devices, hazards caused by small diameter reels being ejected shall be prevented.

NOTE 1 The following are examples of preventative measures that can be taken:

— changing reels at a lower speed;

— preventing the reel from being reduced to a diameter that is less than the minimum reel diameter specified by the supplier;

— fitting an adequate safety device to the unwinding unit.

For web widths greater than 2 000 mm and web speeds greater than 15 m/s, one of the following technical safeguards shall be provided:

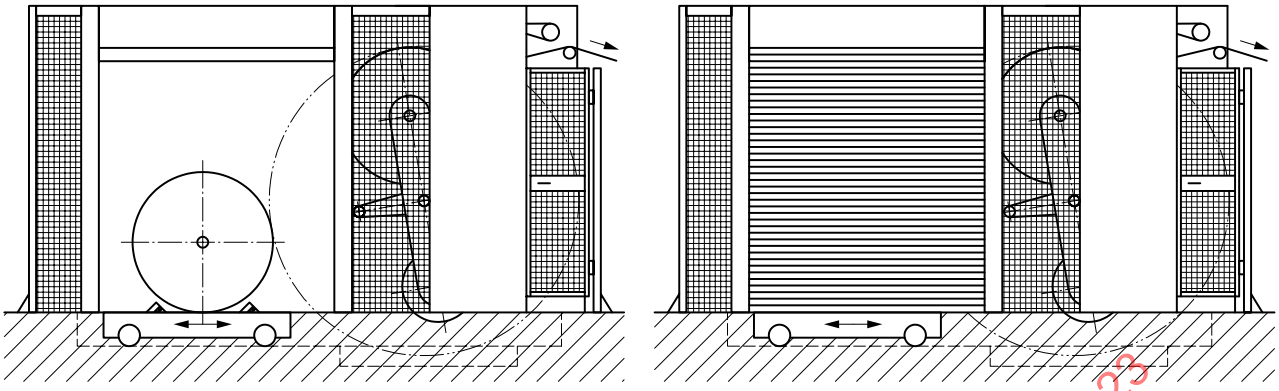
— complete enclosure of the unwinding device,

NOTE 2 For example, in the form of a grid-like enclosure (see Figure 14).

— safety device (e.g. transfer table with fencing) positioned close to the small-diameter reel whose position is monitored by technical measures (see Figure 15, item 4).

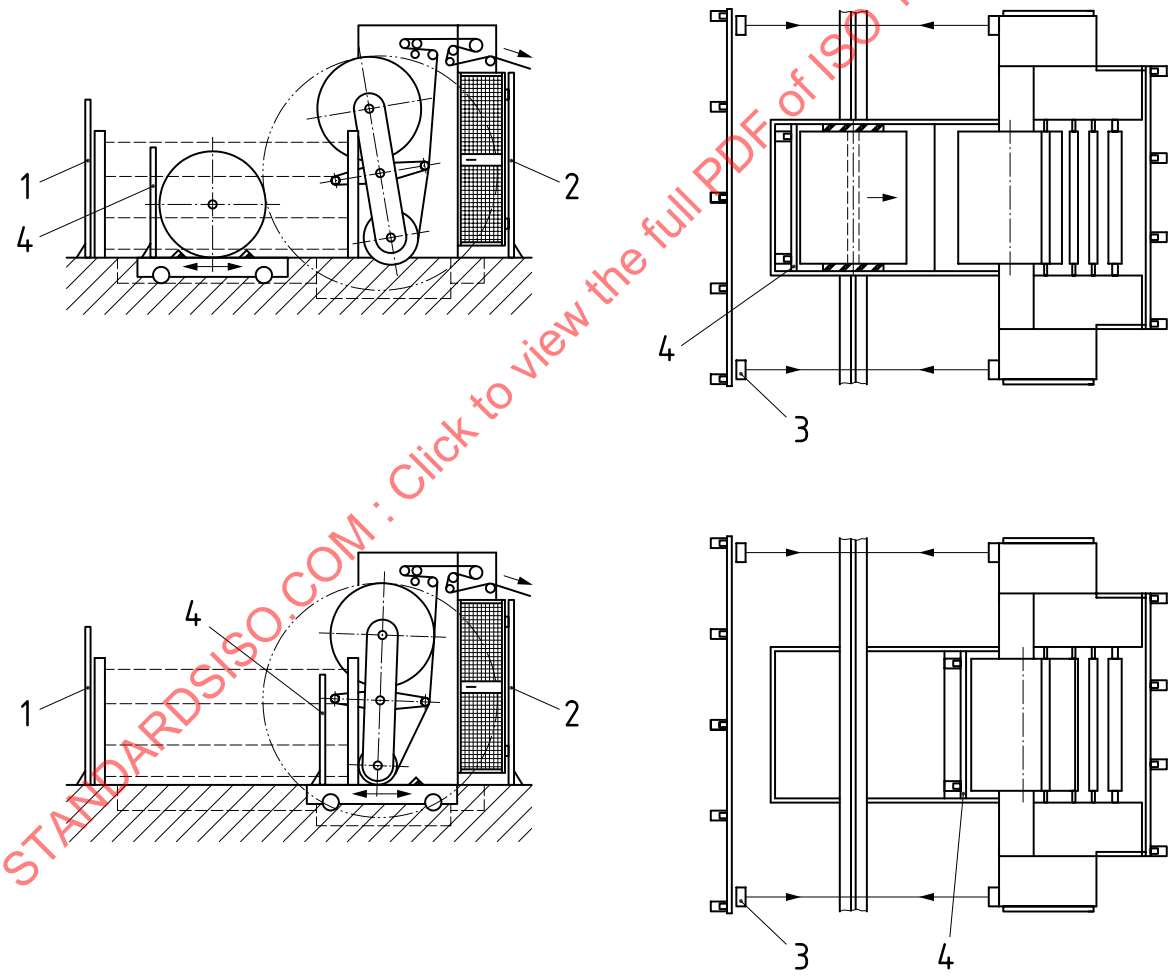
NOTE 3 For example, sensors.

Monitoring of the safety device (e.g. fencing) position shall be in accordance with at least PL d of ISO 13849-1:2023 or SIL 2 of IEC 62061:2021.



a) Guard open b) Guard closed

Figure 14 — Complete enclosure



Key

1 fence at front
2 fence at back
3 light beams
4 fence on transfer table

Figure 15 — Safety device (e.g. fence on transfer table)

5.3.8.5 Hazard points by movement of lifting arms

If hazard points created by the movement of the lifting arms and the turret at the machine frame, respectively, cannot be avoided by built-in design or be safeguarded, the lifting arm(s) and the turret, respectively, shall be movable only in the hold-to-run control mode at a speed that shall not exceed 5 m/min (see 5.3.6 b). Control devices shall be arranged such that hazard points can be observed from the place of actuation.

NOTE Hazard points exist, for example, between the:

— material reel and fixed machine parts,

— material reel and the lifting arm,

— material reel and the pit edge,

— lifting arm and the pit edge,

— material reel and the pit,

— material reel and the floor,

— lifting arm and the floor, and

— material reel and the chucking cones.

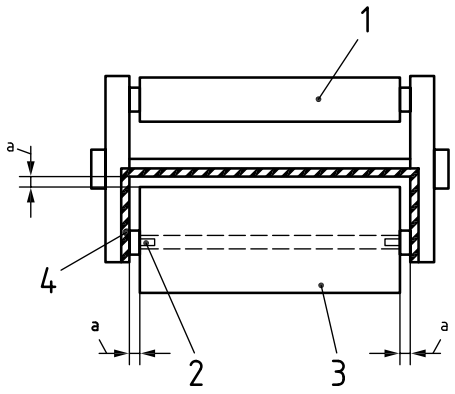
5.3.8.6 Hazard points by rotating material reel

On reel unwinding and rewinding devices, the drawing-in points between the rotating reel and fixed machine parts shall be avoided or safeguarded.

NOTE 1 The draw-in hazard between the front side of the material roll and fixed parts (lifting arms) are avoided if the distance (a) is less than or equal to 4 mm or at least 25 mm (see Figure 16).

A warning as to the temporary residual risk (drawing-in hazard) between the circumferential surface of the material reel and fixed machine parts shall be provided using yellow/black hazard labelling and safety signs at the machine.

NOTE 2 The distance between the circumferential surface of the material reel and the fixed machine parts increases with the decreasing material reel diameter as a result of the unwinding movement.



Key

1 leftover material reel
2 chucking cones
3 new material reel
4 yellow/black safety marking
a Gap between rotating material reel and fixed parts of machine.

Figure 16 — Distances between the front or the circumferential surface and the lifting arms or the fixed machine parts

5.3.8.7 Monitoring of circumferential speed of material reel

Overwinding of the material reel as a result of an excessively high circumferential speed shall be prevented by technical measures during all operating conditions. The processing of the control signals shall be in accordance with at least PL d of ISO 13849-1:2023 or SIL 2 of IEC 62061:2021.

When, due to velocity or mass, the ejection of the material reel can create a hazardous situation, such as crushing the upper body or other irreversible injuries, the safety-related parts of the control system which prevent ejection of the material reel during the changing, unwinding and winding processes shall at least be in accordance with PL d of ISO 13849-1:2023 or SIL 2 of IEC 62061:2021.

5.3.8.8 Unintended lowering of raised arms of loaded material reel

Unintended lowering movement of the raised arms with the loaded material reel shall be prevented by technical measures.

NOTE Such technical measures include, for example:

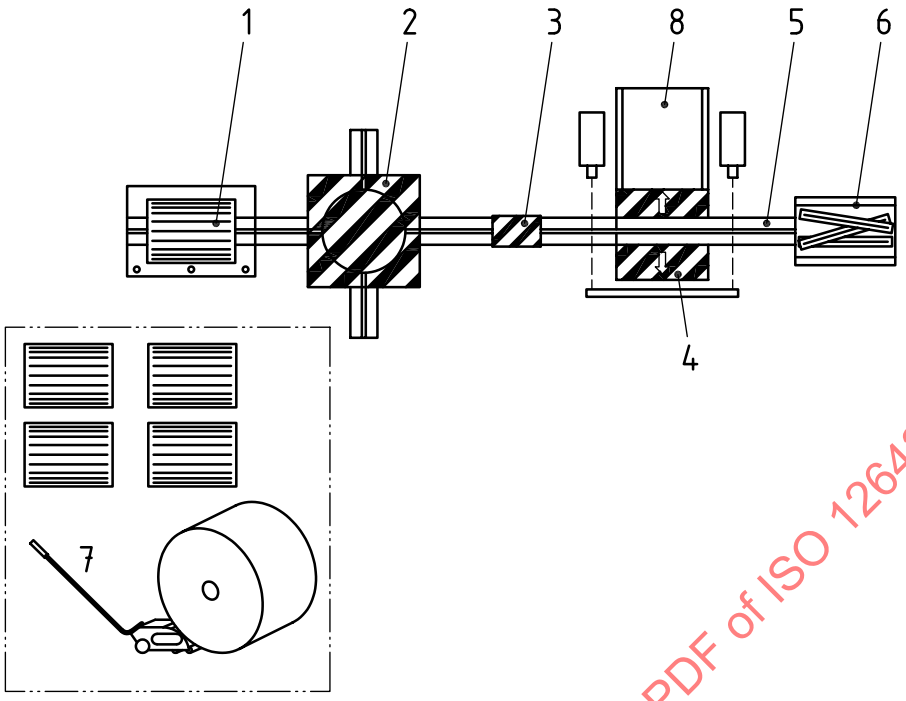
— use of two independently acting brakes, or

— use of a brake with cyclical brake testing.

5.3.8.9 Transport of the material reel to the unwinding device and from the rewinding device

Material reel transport shall be carried out under the following conditions:

— Manual movement of material reels is limited to a maximum material reel width of 2 000 mm or a maximum diameter of 1 524 mm (60 inch diameter). If the roll weight is, due to material density or smaller nominal roll diameter, less than 1,6 tons wider rolls are permitted. The transport of larger reels shall be power driven which includes, for example, the use of a trolley or other mechanical means driving and controlling the reel through the loading path, or hand-operated hydraulically, pneumatically or electrically powered mover.



Key

1 unwrapping station
2 reel platform
3 trolley
4 transfer table
5 transfer track
6 rest reel adapter
7 hand guided reel mover
8 reel unwinding device

Figure 17 — Power driven transport zone of reels

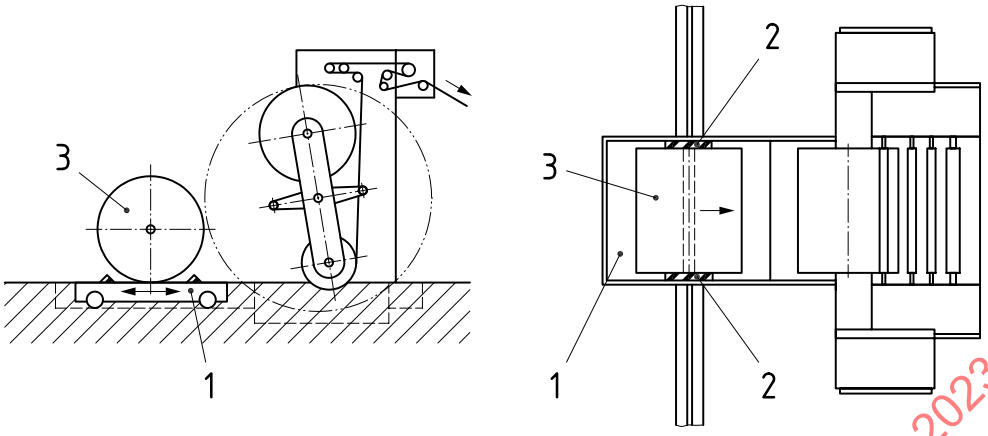
— On semi-automatic reel transport systems, transport of the material reel shall be carried out in the hold-to-run control mode with a maximum speed of 20 m/min. The stopping distance shall not exceed 200 mm. It shall be possible to clearly see the total transport path and all hazards from the respective hold-to-run control position.

— Automatic reel transport is permitted at a speed not to exceed 25 m/min and the stopping distance shall not exceed 200 mm provided that the minimum distances of 500 mm between the material reel with the transport equipment and any fixed parts of the machine or building are maintained, and no hazards are created between the transport equipment and/or material reel and the floor. Otherwise, the entire hazard zone of the material reel transport shall be safeguarded by guards or ESPD(s) (see 5.7.6).

If automatic guided vehicles (AGV) are used for reel transport, ISO 3691-4:2020 shall apply.

Where the material reel transport is performed semi-automatically or automatically with a transfer table, the position of the transfer table shall be monitored to ensure that the transfer table is in the correct position for loading and unloading. (see Figure 18). The related control system shall satisfy at least PL b of ISO 13849-1:2023 or SIL 1 of IEC 62061:2021.

Monitoring by means of sensors is not necessary where the material reel is loaded manually.



Key

1 transfer table
2 sensor
3 new material reel

Figure 18 — Transfer table position monitored by sensors

5.3.8.10 Hazard zone guarding of the entire reel unwinding and rewinding device

5.3.8.10.1 Automatic reel loading systems

On automatic reel-loading systems, the hazard zone at the front (reel loading area) and at the unwinding unit shall be completely safeguarded by electro-sensitive protective devices and/or by guards (see Figure 19).

NOTE 1 Hazard zones exist, for example, between the:

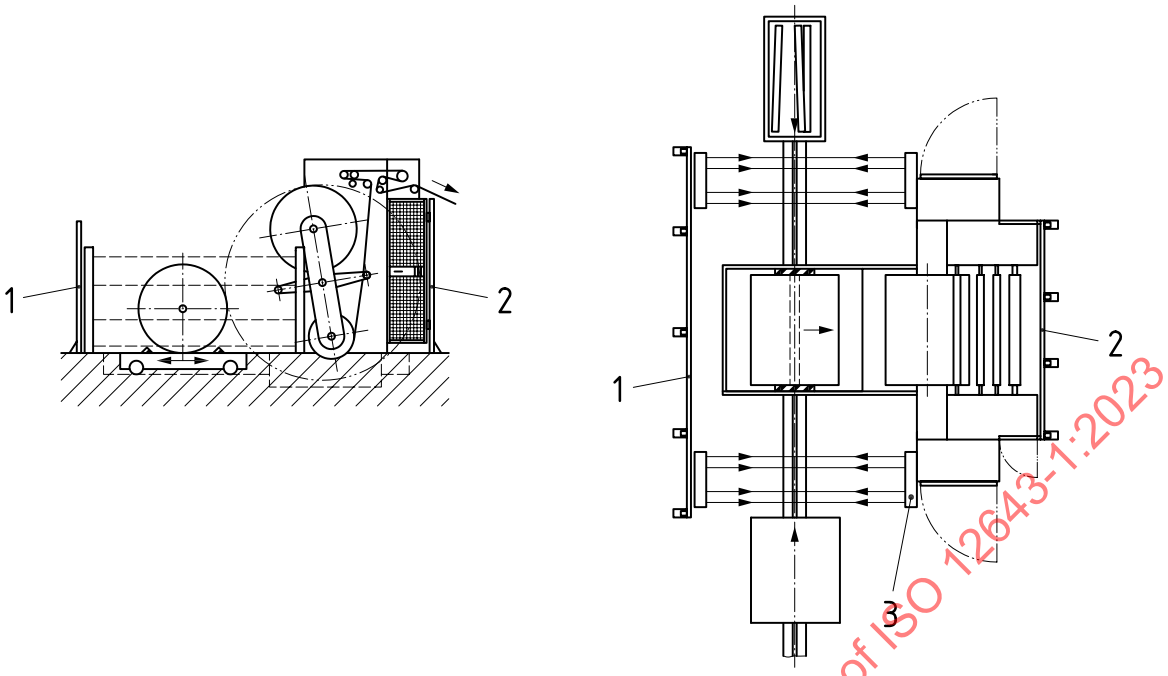
— material reel and the fixed machine parts,

— material reel and the lifting arm,

— material reel and the floor,

— lifting arm and the floor, and

— material reel and the chucking cones.



Key

1 fence at front
2 fence at back
3 light beams of ESPD

Figure 19 — Example of guards and ESPDs at the front and the rear of reel splicer

Where ESPDs, in accordance with 5.7.6, are used for safeguarding the automatic reel-loading area on unwinding units, the device may be muted while material reels or containers with unwound cores are transported through the area safeguarded by the electro-sensitive protective device under the following conditions:

— For reel diameters up to 1 270 mm, an additional ESPD [see Figure 20 a), item 2] is provided at a height (h) of not more than 50 mm above the top of the largest reel. When this beam is interrupted during insertion of the material reel or removal of the unwound material reel, all hazardous movements on the unwinding unit shall stop immediately.

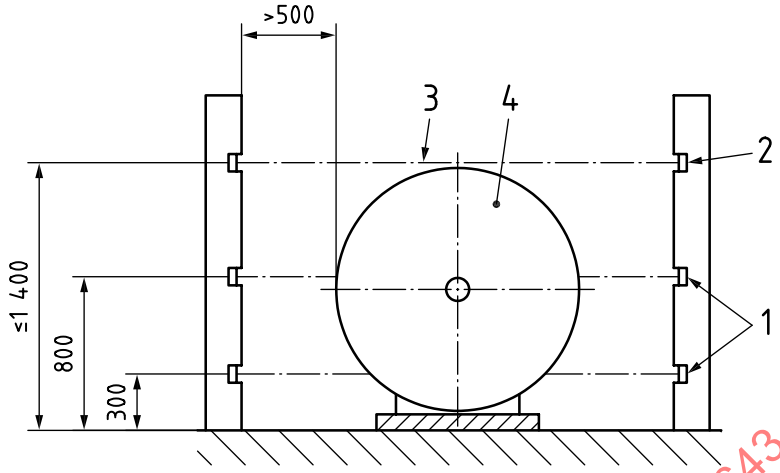
NOTE 2 Interruption of the beam can be caused, for example, by persons accessing the hazard zone, or other intrusions.

— For reel diameters of more than 1 270 mm, two additional ESPDs arranged cross-wise [see Figure 20 b), item 2] are provided that will cause immediate stopping of all hazardous movements in the automatic loading area of the unwinding unit during insertion of the material reel or removal of unwound cores whenever the beam of the ESPD is interrupted. The lower points of the permanent ESPDs are always positioned at a height of not more than 1 400 mm. The counterpart shall be positioned such that the largest material reel can be inserted without the light beam being interrupted.

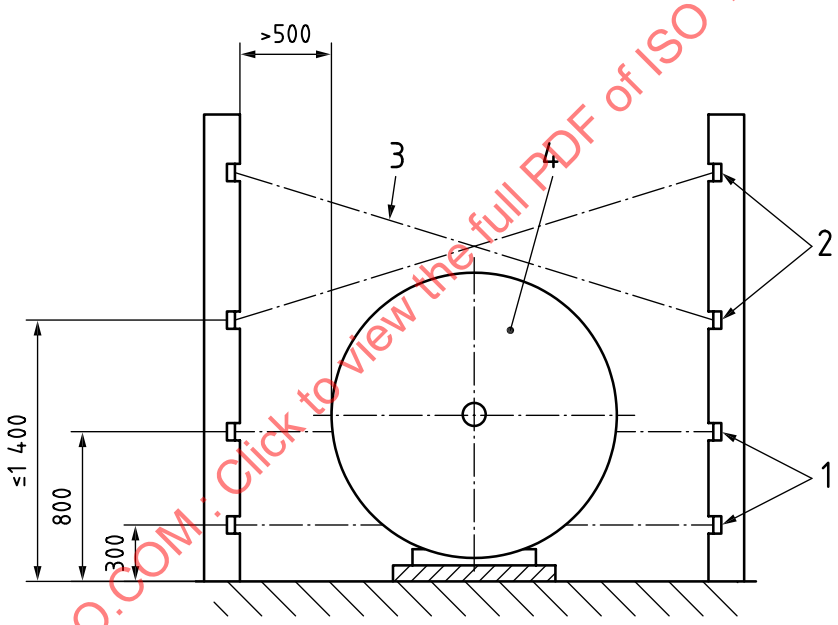
— Emergency stop devices on the reel unwinding unit that will also stop the automatic loading operation shall be provided at locations determined by the risk assessment.

— The requirements of ISO 13855:2010 shall be satisfied.

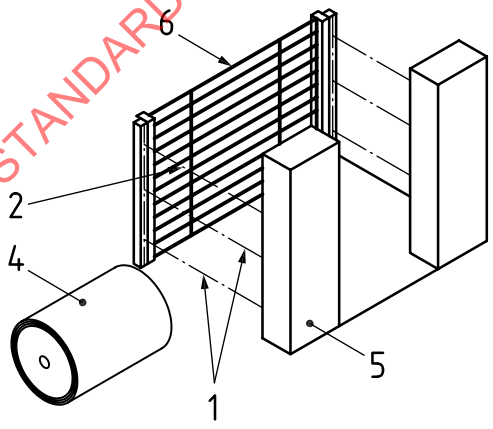
Dimensions in millimetres



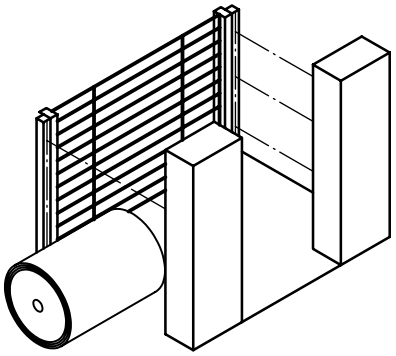
a) Reel diameter 1 270 mm (50"), side view



b) Reel diameter 1 524 mm (60"), side view



c) Reel before transport into the safeguarded area [all ESPD(s) are active]



d) Reel entering the safeguarded area [only permanent ESPD(s) are active]

Key

1	ESPDs with muting function	4	material reel
2	permanent ESPD(s)	5	side frame of reel stand
3	light beams of ESPDs	6	fence

Figure 20 — Unwinding unit — Safeguarding automatic reel loading area and muting

5.3.8.10.2 Manual reel loading systems

Where reels are loaded manually, safeguarding of the front hazard zone (reel loading area) according to 5.3.8.10.1 is not required if all hazardous movement of the reel unwinding device can only be activated in hold-to-run mode with a maximum hold-to-run speed of 5 m/min. It shall be possible to observe the hazards and/or hazardous movements from the place where the hold-to-run pushbutton is positioned.

NOTE Examples of hazardous movements include the following:

— rotations of lifting arms;

— displacement of lifting arms.

Where these requirements cannot be met, 5.3.8.10.1 shall also be satisfied for manual reel loading.

For safeguarding of the hazard zone by means of ESPDs, see 5.3.7.3.

5.3.8.10.3 Safeguarding of the rear hazard zone

The hazard zone at the rear of the reel unwinding device shall be safeguarded.

NOTE 1 An example of a means of safeguarding is the use of a fence with an interlocked access door.

If it is possible for a person to gain access from the front to the rear hazard zone, this shall be safeguarded according to 5.3.8.10.1 when any dangerous movements are possible.

NOTE 2 For example, this can be achieved by sensors and/or ESPDs.

Opening of the interlocked door shall only be possible when all hazardous movements have come to a halt or when the moved machine parts are in a safe position. At the beginning of the production process operators may access the rear of the reel unwinding device only if the machine is at standstill or operating in the unwinding condition and no other hazardous motion is possible. After the operator leaves the rear of the reel unwinding device and the production process is initiated, guard locking shall be activated when the drawing-in speed has been exceeded. The requirements of 5.3.8.2 to 5.3.8.4 shall be satisfied.

Activation of an additional control device according to 5.3.8.2 to 5.3.8.4 is not required if the presence of persons within the hazard zone is detected.

NOTE 3 For example, by laser scanner.

The control system of the ESPDs and interlocking guard with guard locking shall be in accordance with at least PL d of ISO 13849-1:2023 and SIL 2 of IEC 62061:2021.

Additionally, in order to caution against crawling under a material reel of full or partial width from the front to the rear hazard zone at reel unwinding devices, warnings shall be provided in the form of symbols affixed to the machine.

NOTE 4 Activating the area protection at the front side of the unwinding device stops all hazardous movements except the unwind movement of the reel. If reels of half width are used there is the possibility to crawl to the rear zone of the unwinding device.

5.3.8.11 Reel rewinding device with contact/pressure roller

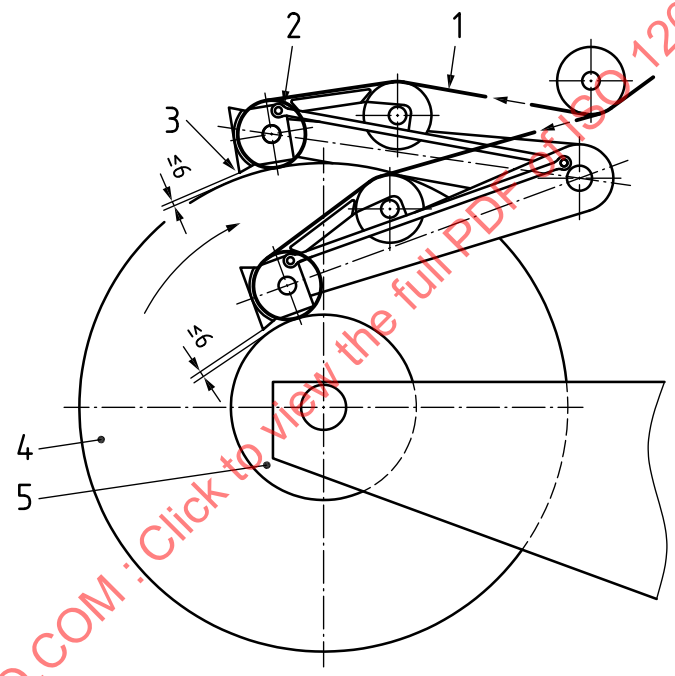
5.3.8.11.1 Protective devices on reel rewinding devices with manual reel change

The hazard point between the material reel and the contact/pressure roller shall be safeguarded by means of one of the following measures:

— safeguarding of the hazard zone by fixed guards, interlocking guards and/or by electro-sensitive protective devices (ESPDs) according to 5.7.6;

— self-adjustable nip guard in the form of a protective profile before the in-running nip according to 5.3.4. The protective profile shall be effective with each reel diameter and shall also safeguard the access from the face side of the reel;

— limitation of the pressing force of the contact/pressure roller to 150 N max. under the condition that there is no drawing-in hazard for the head.



Key

1 web
2 contact/pressure roller
3 protective profile
4 material reel with large diameter
5 material reel with small diameter

Figure 21 — Self-adjustable nip guard at manual reel rewinding devices

5.3.8.11.2 Protective devices at reel rewinding devices with automatic reel change

Hazard points due to the rewinding movement of the material reel and the reel change shall be safeguarded by one or more of the following:

— fixed guards;

— interlocking guards;

— electro-sensitive protective devices (ESPDs) according to 5.7.6.

NOTE 1 Such hazards are generated by, for example:

— lowering and/or lifting movements of the impact cutting device [separating device and pressure roller, see Figure 22 a)];

— movement of the contact/pressure roller;

— cutting-off movement of the cutting knife;

— rotational movement of the turret.

Activation of the safeguarding of the hazard zone (ESPDs according to 5.7.6.) causes the immediate stop of all hazardous movements except the actual rewinding movement of the material reel, including the linear movement of the contact/pressure roller due to the increase in reel diameter.

The hazard point between the material reel and the contact/pressure roller or lay-on-roll shall be safeguarded by one of the following measures:

— safeguarding of the hazard zone by fixed guards, interlocking guards and/or by electro-sensitive protective devices according to 5.7.6.

— self-adjustable nip guard in the form of a protective profile before the in-running nip

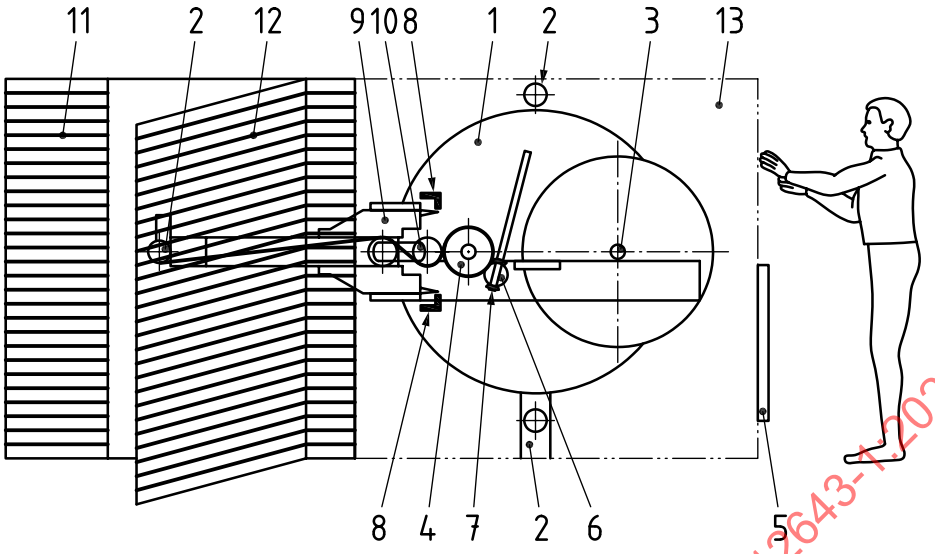
NOTE 2 The guard can extend across the entire working width.

— limitation of the pressing force of the contact/pressure roller to 150 N max. under the condition that there is no drawing-in hazard for the head.

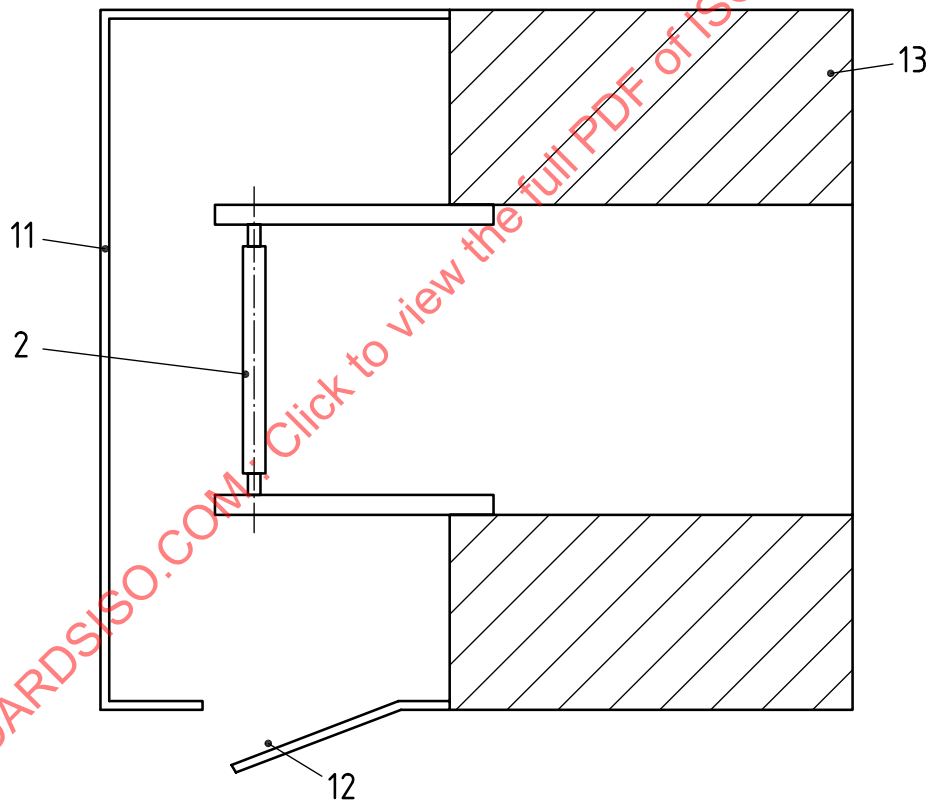
If safeguarding of the nip between the material reel and the contact/pressure roller cannot be achieved completely by means of a fixed guard in the form of a protective profile before the nip according to 5.3.4, the nip shall be safeguarded by fixed guards and/or electro-sensitive protective devices to provide protection to prevent any inadvertent reflex-like access to the nip (fast straight access).

NOTE 3 In addition to a fixed guard as protection of the nip between the material reel and the contact/pressure roller by means of an ESPD, this can, for example, also be ensured by an ESPD detecting any approach to the nip, with such detection resulting in the release of the contact/pressure roller so that the drawing-in hazards are prevented.

NOTE 4 Figure 22 a) and b) show the basic principle of automatic reel change: The full material reel is in position 3. The lay-on roll 6 is at the empty material reel 4. After the roll change the full material reel can be removed. When the material reel has been removed, the new core need to be taken into position 3, whereby, depending on the roll diameter in 4, the in-running nip (gap) between 4 and 6 as well as between 4 and 10 can be reached (independent from the reel diameter).



a) Side view of the rewinder



b) Top view of the rewinder

Key

1	turret	8	guard on cutting knife
2	guide rollers	9	separating device
3	rewinding positions 1	10	pressure roller
4	rewinding positions 2	11	fence
5	light barrier	12	access door
6	lay-on roll	13	side frame
7	guard on lay-on roll		

Figure 22 — Basic principle of automatic reel change

5.3.9 Threading of web material

On machines, safe threading of the web-type material shall be ensured. For certain types of machines, this can require the use of auxiliary threading devices.

On power-driven threading devices for web-type material, access to hazard points shall be prevented by guards.

Access to hazard points is considered prevented if any of the following conditions are satisfied:

— on rope-type threading devices, the in-running nips between the threading rope and the idler pulley are safeguarded. Safeguarding can include the provision of a fixed disc on the outside of the pulleys, the radius of which is at least 120 mm larger than the radius of the pulley;

— on power-driven bar-type threading devices with transport chains, the in-running nips between chains and chain wheels are protected by guards that fill the in-running nips as far as possible; or

— threading is carried out under hold-to-run control with speed limitation.

5.3.10 General requirements for feeding units and delivery units

5.3.10.1 Pile lifting and lowering devices

5.3.10.1.1 Static load test and dynamic load test

A pile lifting and lowering device integrated as part of a system shall be designed such that it can withstand a static load test with a load of 1,25 times the maximum load capacity without showing permanent deformations or apparent defects. It shall withstand a dynamic load test with a load of 1,1 times the maximum load capacity under normal operating conditions.

NOTE 1 Examples of this type of equipment include the feeder and delivery on a sheet-fed press, pile lifting device on a guillotine cutter, a feeder on a sheet folding machine, a delivery on a rotary sheeter on a web press, etc. Devices such as cranes, scissor lifts and hoists are generally stand-alone equipment, and not covered by this requirement.

NOTE 2 If the required tests are not done within a type test of the device and if the pile lifting and lowering device will not be assembled at the manufacturer in the form in which it is to be used, then every unique device needs to be tested at the manufacturer or at the place of use.

5.3.10.1.2 Breaking strength of steel link chains

On lifting and lowering devices with production format sizes larger than 2,5 m^2, the breaking strength of the steel link chains shall be at least six (6) times the permissible static load; on pile lifting and lowering devices with production format sizes up to and including 2,5 m^2, the breaking strength of the steel link chains shall be at least three (3) times the permissible static load.

Calculations shall be based on a minimum specific density of 1 400 kg/m^3 for paper and a minimum specific gravity of 200 kg/m^3 for corrugated board.

5.3.10.1.3 Movement limitation in case of component failure

On pile lifting and lowering devices with production format sizes larger than 2,5 m^2, and a lifting height greater than 1,5 m, provisions shall be made to prevent the pile carrier from moving more than 100 mm in case of failure of a rope, chain, supporting nut or gear drive in areas where such failure may cause injury.

EXAMPLE This requirement is satisfied for spindle drives, for example, by providing an additional nut of the same type as the supporting nut in order to back up the supporting nut in the event of a breakage or thread wear. The requirement is satisfied for chains (or ropes), for example, by providing one or more unloaded double chains that, in the event of a chain breakage, take over the load and function of the operating chain.

This requirement is not applicable to gears that are rated for double load. This requirement is also not applicable to lifting and lowering devices with a hydraulic or pneumatic drive if, in case of leakage in the pipe system, the lowering speed of the pile carrier does not accelerate to more than 1,5 times the speed under normal operating conditions.

5.3.10.1.4 Whole-body access below the pile carrier

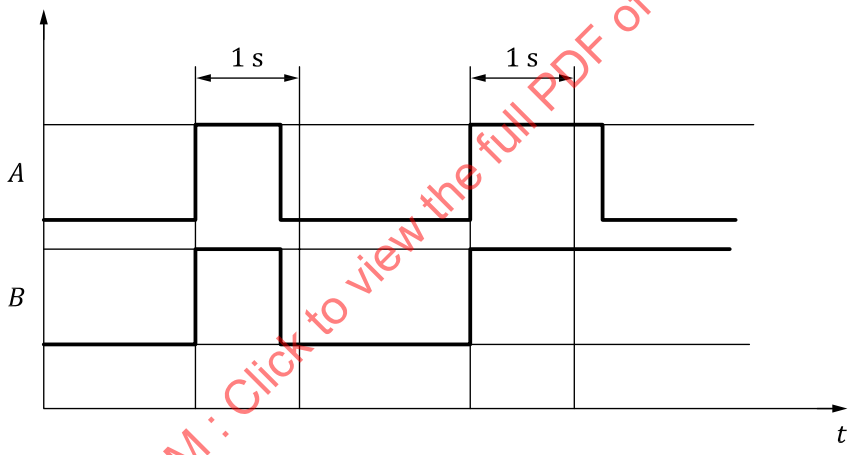
On pile lifting and lowering devices, the area below the pile carrier and the lowerable auxiliary pile device shall be safeguarded against whole-body access by guards or by electro-sensitive protective devices where:

— the lowering movement is carried out automatically or with self-holding (button has to be pressed to start movement and held for at least one second for the transition to continuous movement),

or

— visibility of the hazard zone below the pile carrier from the operating position is not guaranteed.

NOTE 1 See Figure 23 for description of self-holding mode.



Key

A status of the pushbutton (pressed/ released)

B movement

Figure 23 — Example of the signal sequence during self-holding mode

As an exception, a lowering movement with self-holding without safeguarding against whole-body access is permitted for pile lifting and pile lowering devices with a product format size up to and including 1 m^2 where the height below the pile carrier or the lowerable auxiliary pile device at the start of the lowering movement with self-holding does not exceed 1 800 mm and the hazard zone can be viewed from the operating position.

For the re-adjustment of the pile carrier or the lowerable auxiliary pile device during production at delivery units, no safeguarding against whole-body access is required with product format sizes up to and including 1 m^2.

NOTE 2 This constitutes an acceptable risk from the slow lowering speed and the low likelihood of persons being present due to the running production process (clearly noticeable machine run).

ISO 13855:2010 need not be considered regarding the approach speed.

5.3.10.1.5 Hazard points between the pile carrier and the place where the operator may stand

On pile carriers, the hazard points between the edges of the pile carrier and the place where the operator may stand shall be safeguarded by one of the following means.

a) On feeders with production format sizes of up to and including 1,0 m^2, and on deliveries with format production sizes of up to and including 0,175 m^2, the pile carrier shall be allowed to lower automatically down to a height of 120 mm above the floor, and further down to the base only in the hold-to-run control mode.

b) On feeders with production format sizes larger than 1,0 m^2, and on deliveries with format production sizes larger than 0,175 m^2, one of the following protective measures shall be provided in order to safeguard the exposed edges of the pile carrier.

   1) Resilient, non-switching, overhanging shields with their forward edges protruding over the hazardous edges by at least 250 mm (see Figure 24).

   2) Electro-sensitive protective devices located in front of the pile carrier edges. ISO 13855:2010 need not be considered. The movement of the pile carrier may be automatically initiated when the electro-sensitive protective device is no longer actuated.

   3) A horizontal distance of 300 mm between the vertical projection of the machine frame and the pile carrier. The protruding parts of the machine frame shall not be higher than 1,5 m above the base. Carrier arms reaching into the safety distance (300 mm) shall be at least 120 mm above the floor (see Figure 25). To lower the pile carrier below 120 mm, hold-to-run control shall be used.

   4) Pressure-sensitive bumpers or trip devices.

   5) Hold-to-run operation. The hold-to-run control shall be at a horizontal distance of at least 850 mm from the hazard point and at a position from where the hazard point is in the operator's view.

c) On feeders and deliveries with production format sizes larger than 2,5 m^2, the hazard point shall be safeguarded by one or more of the following safety devices:

   1) guard;

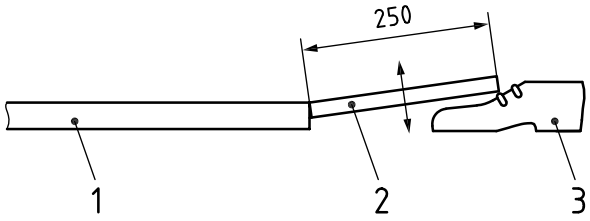
   2) Electro-sensitive protective device in front of the edge of the pile carrier, or on corrugated board feeding and delivery units by an ESPD fitted at a distance of 300 mm minimum from the edge of the pile carrier;

   3) other presence sensing devices as defined in 5.3.7.3 and 5.3.7.4.

d) On delivery units, where a pile mass of 500 kg is not exceeded, crushing of the toes shall be prevented as defined in ISO 13854:2017 by providing a clearance of 50 mm between the lower edge of the pile carrier and the floor. In addition, the lowering movement shall be permitted only in the normal operating mode of the machine or under hold-to-run control.

The wheels, for example of a pile carrier, shall be fitted as close to the centre of the pile carrier as possible without decreasing stability.

Dimensions in millimetres



Key

1 pile carrier
2 overhanging shield
3 foot

Figure 24 — Overhanging shield

Dimensions in millimetres

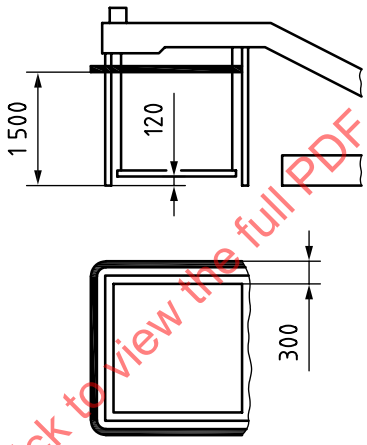


Figure 25 — Safeguarding by deflecting parts of the machine frame

Where working platforms or passageways are fitted to the feeding or delivery unit, the hazard point between working platform or passageway and the edge of the pile carrier shall be safeguarded.

NOTE 3 For example, this can be achieved by one of the following measures:

— minimum distance of 120 mm between pile carrier edge and edge of the working platform;

— electro-sensitive protective devices in front of the pile carrier edge (ISO 13855:2010 need not be considered);

— horizontal distance of 300 mm between the vertical projection of the outer edge of the machine frame and pile carrier edge, with protruding parts of the machine frame arranged at a maximum distance of 1,5 m above platform or gangway;

— trip devices.

5.3.10.1.6 Safeguarding the upward movement of the pile carrier

On feeding and delivery units, the crushing and shearing points caused by the upward movement of the pile or pile carrier shall be safeguarded.

Protective measures are, for example, one or more of the following measures:

— safety distances and minimum gaps in accordance with ISO 13857 :2019 and ISO 13854:2017;

— guards;

— electro-sensitive protective devices in accordance with 5.3.7.3;

— hold-to-run operation at a position from where the hazard point is in the operator's view;

— trip devices in accordance with 5.7.7.

5.3.10.2 Pile-changing devices for feeding and delivery units

Where the movement of pile-changing devices causes a crushing hazard between the pile-changing device, the pile lifting and lowering device, the paper pile and fixed machine parts, protective measures shall be provided. This can be achieved by means that include, but are not limited to:

— fixed or interlocking guards in accordance with 5.3.2;

— electro-sensitive protective devices in accordance with 5.3.7.3;

— safety distances and gaps in accordance with ISO 13857:2019 and ISO 13854:2017;

— hold-to-run control in accordance with 5.3.6;

— trip devices in accordance with 5.7.7.

5.3.10.3 Safeguarding of the separating elements when separating at the bottom of the pile

Separating elements on feeders shall be designed such that their movement does not create hazard points.

Where sheets are fed from the bottom of the pile, safeguarding is achieved, for example, by residual pile monitoring system on feeders.

NOTE The term "sheet" includes single sheets, folding sheets (signatures) or blanks among others.

The hazard points on separating elements outside the side lays on feeders shall be safeguarded for every format size used. This may be achieved, for example, by using concertina-type bellows or additional guards.

5.3.10.4 Safeguarding of the separating elements when separation at the top of the pile

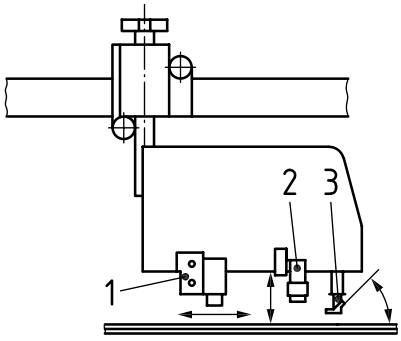
Hazard points on suction head drive gears that can be accessed during the production process shall be safeguarded by guards completely enclosing the suction head, leaving only the bottom open (see Figure 26). Hazard points caused by moving parts outside the suction head (such as a forwarding sucker or lifting sucker) shall be safeguarded by one or more of the following measures:

a) a distance of at least 25 mm is maintained between moving parts, such as a forwarding sucker, that are accessible during production;

b) the parts are moved only by springs with a non-hazardous low force (e.g. pressure foot, lifting sucker);

c) all hazard points (shearing and crushing hazards) are protected by guards.

The drive shaft (universal shaft) of the suction head shall be completely enclosed.



Key

1 forwarding sucker
2 lifting suckers
3 pressure foot

Figure 26 — Movement of the suction head

5.3.10.5 Pull-in and forwarding wheels

In-running nips on the pull-in and forwarding wheels on the sheet feeding system shall be safeguarded.

This can be achieved, for example, by one or more of the following:

— using a deflection of 25 mm and an evasive force that does not cause irreversible injuries to fingers or hand. This is ensured when the contact pressure of the pressure roller is 70 N maximum; using a deflection of 15 mm in combination with roller widths limited to 25 mm and an evasive force that does not cause irreversible injuries to fingers or hand. This is ensured when the pressure force of the pressure roller is 70 N maximum;

— providing guards in accordance with 5.3.4.

5.4 Requirements for protection against other hazards

5.4.1 General

Protection shall be provided against other hazards as defined in 5.4.2 to 5.4.17. (See also Annex B).

5.4.2 Fire and explosion protection

5.4.2.1 Explosion protection

5.4.2.1.1 General

For machinery where combustible/flammable substances are used or permanent combustible dust deposits can form, explosion hazards that can result from the formation of explosive atmospheres shall be prevented by measures in accordance with 5.4.2.1

Procedures for identifying and assessing hazardous situations and the principles of risk minimisation are described in EN 1127-1:2019.

Explosion protection is not required for machinery where

— where no formation of combustible dusts occurs,

— no combustible liquids are sprayed, and

— no liquids with a flash point below 60 °C being used and the liquids remain sufficiently below their flash point under all operating conditions, even when taking into account possible temperature influences due to the production process, the machine and ambient conditions.

Where hazardous areas can occur as a result of gases, mists, vapours or dusts emitted by machinery, these areas shall be identified for the applicable equipment in accordance with Annex F and IEC 60079-10-1:2020 for explosive gas atmospheres or IEC 60079-10-2:2015 for explosive dust atmospheres.

The use of the terms "potentially explosive atmospheres" and "zones" in this document is limited to the selection of equipment, protective systems and protective measures.

NOTE 1 If local conditions (for example due to ventilation, storage of solvent-based inks at the machine) differ from the typical conditions assumed in this document, it is the user's responsibility to give special consideration to the zones when defining the explosion protection document.

NOTE 2 National regulations can exist for fire and explosion protection. In the USA, for example, NFPA 70:2014 applies. Where the equipment protection levels (EPL) are identified in the area classification documentation, those requirements are the basis for selection of the ex equipment. Unless national regulations prohibit, as an alternative to the relationship given in Annex G between EPLs and zones, EPLs can be determined on the basis of a risk assessment, for example taking into account the consequences of an ignition.

NOTE 3 The classification of zones 0,1,2 or 20,21,22 (hazardous areas) according to IEC 60079-10-1:2020 or IEC 60079-10-2:2015 and NFPA 70:2014, Article 505 (Class I) or Article 506 is identical.

NOTE 4 An overview of the relationship between zones, equipment to be used and types of protection is given in Annex G.

5.4.2.1.2 Avoidance of the formation of potentially explosive atmospheres

The formation of potentially explosive atmospheres shall be avoided or minimised by the following measures:

— avoidance of liquids with a flash point below 60 °C;

— avoiding sprays of combustible or flammable liquids;

Instructions for minimising the quantities of combustible/ flammable liquids on the machine and the use of liquids with a flash point preferably 60° or higher should be stated in the instruction handbook.

— if integrated washing systems are provided, by limiting the amount of washing liquids with a flash point below 60°C applied by integrated washing systems;

— The temperature of any combustible/flammable liquid shall remain sufficiently below its flash point under operating conditions. The lower explosion limit should not be exceeded. This can normally be achieved by keeping the maximum temperature for pure, non-halogenated liquids 5 K below the flash point and the maximum temperature for solvent mixtures without halogenated components 15 K below the flash point of the liquid which has the lowest flash point in the mixture.

The devices and systems shall be designed and constructed such that dust accumulations are avoided as far as possible. If this is not possible, interfaces for dust extraction systems shall be provided or specifications for regular cleaning shall be made in the instruction handbook.

The instruction handbook shall refer to the need for regular cleaning of dust deposits.

The instruction handbook shall refer to adequate ventilation of the areas where potentially explosive atmospheres can occur.

If the formation of hazardous explosive atmospheres cannot be avoided, additional measures shall be taken. Risk reduction can be achieved by avoiding any possible effective ignition sources and/or by protective measures such as isolation, venting, suppression or containment.

5.4.2.1.3 Avoidance of effective ignition sources

5.4.2.1.3.1 Determination of effective ignition sources

All potential ignition sources shall be identified and evaluated.

All electrical and non-electrical equipment and all components intended for use in potentially explosive atmospheres shall be designed and built in accordance with the required categories for Group II equipment, according to EN 1127-1:2019 or ISO 80079-36:2016; and IEC 60079-0:2017, to ensure that the generation of ignition sources described in EN 1127-1:2019, 5, is avoided.

Possible ignition sources are, but not limited to:

— hot surfaces;

— flames and hot gases (including hot particles;

— mechanically generated impact, friction and grinding;

— electrical apparatus;

— stray electrical current, cathodic corrosion protection;

— static electricity;

— lightning;

— radio frequency electromagnetic waves from 10^4 Hz to 3 x 10^{11} Hz;

— ionizing radiation;

— ultrasonic waves;

— adiabatic compression and shock waves;

— exothermic reactions, including self-ignition of dusts.

In order to classify electrical equipment, they shall be subjected to an ignition hazard analysis according to EN 1127-1:2019. In order to classify non-electrical equipment, they shall be subjected to an ignition hazard analysis in accordance with ISO 80079-36:2016.

NOTE 2 For guidance on avoiding the build-up of electrostatic charges and on ungrounded metallic components, see IEC 60079-0:2017, IEC/TS 60079-32-1:2013+AMD1:2017 and ISO 80079-36:2016

5.4.2.1.3.2 Limiting the temperature of equipment

Where the settling of combustible dusts cannot be avoided, it shall be ensured that the surface temperature of all equipment shall not exceed a minimum ignition temperature reduced by a safety distance.

EXAMPLE The necessary safety distance between the maximum permissible surface temperature and the glow temperature under the presence of dust deposits can be determined, for example, in accordance with IEC 60079-14:2013, 5.6.3.3. For example, for dust layers up to 5 mm thickness, the surface temperature is set to a value that is at least 75 K below the glow temperature. For dust layers > 5 mm thickness, the maximum surface temperatures are significantly lower.

It shall be ensured by the selected temperature class that the electrical devices do not represent an ignition source.

NOTE For a description of the classification of the surface temperatures of electrical equipment, see IEC 60079-0:2017 and ISO 80079-36:2016.

The maximum surface temperature of equipment shall not exceed 80 % of the ignition temperature of the gases or vapours measured in degree Celsius (°C). The surface temperature of hot parts where there is a danger of contact with dust clouds shall not exceed 2/3 of the lowest ignition temperature of the dust cloud measured in °C, in accordance with EN 1127-1:2019.

5.4.2.1.3.3 Avoidance of ignition sources by non-electrical devices and non-electrical equipment

All non-electrical devices and non-electrical equipment (e.g. brakes. clutches, pumps) intended for use in potentially explosive atmospheres (hazardous areas) shall be in accordance with the requirements of IEC 60079-0:2017, ISO 80079-36:2016, ISO 80079-37:2016 and any applicable standards for the respective types of protection in accordance with the required equipment protection levels for Groups II and III.

5.4.2.1.3.4 Avoidance of ignition sources by electrical devices and electrical equipment

All electrical devices and electrical equipment that are intended for use in potentially explosive atmospheres (hazardous areas) shall fulfil, in accordance with the required equipment protection levels for Groups II and III, the requirements of IEC 60079-0:2017 and the requirements of the standards that may be applicable for the respective types of protection. The design, selection and installation shall be in accordance with IEC 60079-14:2013

Any electrical equipment located and installed in a potentially explosive atmosphere classified as Zone 2 for gases and vapours or Zone 22 for dust shall comply with at least Category 3G of EN 1127-1:2019 and shall meet the requirements of IEC 60079-14:2013.

Any electrical equipment located and installed in a potentially explosive atmosphere classified as Zone 1 for gases and vapours or Zone 21 for dust shall comply at least with Category 2G of EN 1127-1:2019 and shall meet the requirements of IEC 60079-0:2017. Where relevant, the requirements of IEC 60079-0:2017 can be supplemented and/or modified by requirements of

— IEC 60079-1:2014,

— IEC 60079-2:2014,

— IEC 60079-5:2015+AMD1:2022,

— IEC 60079-6:2015+AMD1:2020,

— IEC 60079-7:2015+AMD1:2017,

— IEC 60079-11:2011,

— IEC 60079-13:2017,

— IEC 60079-14:2013,

— IEC 60079-18:2014+AMD1:2017,

— IEC 60079-25:2020,

— IEC 60079-26:2021,

— IEC 60079-28:2015,

— IEC 60079-31:2022, and

— IEC 60079-33:2012,

depending on applicability.

Fans working in hazardous areas (vapour, dust, etc.) shall be designed, in accordance with the requirements for hazardous areas, they:

— do not create an ignition hazard;

— are suitable for the mechanical, thermal and chemical stresses;

— can be safely operated during the intended service life, including normal and possible technical malfunction as well as forseeable misuse.

NOTE 1 For further information on the design and testing of fans for use in potentially explosive atmosphere see EN 14986:2017.

For the pumping units at storage tanks for inks, coating substances, impregnating material or adhesives, electric drive motors shall be suitable for the ambient conditions prevailing there.

NOTE 2 The type of protection for the drive motor pumping units is often "d" according to IEC 60079-1:2014 or "e" according to IEC 60079-7:2015+AMD1:2017

NOTE 3 Ambient conditions are, for example, the operating temperature or service temperature of the machinery or assembly or parts of the machine.

5.4.2.1.3.5 Avoidance of electric sparks due to static electricity

To avoid electrostatic discharge, hoses and pipes used for combustible or explosive materials shall be at least electrically grounded and dissipative (resistance less than 10^6 Ω over the total length of the hose) or shall meet the requirements of ISO 80079-36:2016. Further requirements shall be observed when using liquids with low conductivity (e.g. toluene) or in processes that generate a large amount of charge.

EXAMPLE Examples of combustible or explosive materials include, but are not limited to, paper, paper dust, plastic swarfs, inks, coatings, adhesives, solvents over a certain concentration, etc.

If the solvent concentration under any single failure exceed 25 % of the lower explosion limit (LEL), then hoses and pipes used for exhausting solvent vapours shall be at least electrically grounded and dissipative (resistance less than 10^6 Ω over the total length of the hose), or shall meet the requirements of ISO 80079-36:2016.

NOTE 1 Measurement of resistance can be made in accordance with ISO 8031:2020 for example. An overview of resistance measurement methods is given in IEC 60079-32-2.:2015.

NOTE 2 Guidance on the risk of ignition from electrostatic discharge can be found through solutions defined by IEC/TS 60079-32-1:2013+AMD1:2017.

Hazardous electrostatic charges shall be avoided by grounding of all conductive parts.

If electrostatic charges, which are generated by highly charge-generating processes (including fast running paper and plastic webs), cannot be completely dissipated by discharging or equipotential bonding, additional technical equipment such as active or passive discharging devices (deionizers) are required.

NOTE 3 Recommendations can be found in IEC/TS 60079-32-1:2013+AMD1:2017.

NOTE 4 See IEC 60079-0:2017, IEC/TS 60079-32-1:2013+AMD1:2017 and ISO 80079-36:2016 for information on avoiding the build-up of electrostatic charges and on unearthed metallic components.

5.4.2.2 Fire protection

ISO 19353:2019 shall be used for preventive and defensive fire protection measures.

As far as necessary, the fire protection of the machine and the fire protection system of the user shall be coordinated and the responsibility for the execution of the individual technical measures shall be coordinated.

NOTE Deviations from these requirements can be specified in the machine-specific parts of the ISO 12643 series.

5.4.3 Electrical equipment

5.4.3.1 General

All electrical equipment shall be designed in accordance with IEC 60204-1:2016+AMD1:2021, such that electrical hazards (such as electric shock or burns) are prevented. The requirements of IEC 60204-1:2016+AMD1:2021 shall be fulfilled, taking into account the additional requirements specified in 5.4.3.2 to 5.4.3.6.

5.4.3.2 Supply-disconnecting device

Machines shall be provided with a device to disconnect the electric power supply. The supply-disconnecting device shall be either a switch-disconnector, with or without fuses, in accordance with IEC 60947-3:2020, utilization Category AC-23B or Category DC-23B, or a circuit-breaker suitable for isolation in accordance with IEC 60947-2:2016+COR1:2016+A1:2019.

The device shall be provided with a means to be locked in the OFF position.

If actuation of a stopping device causes a low-voltage (under-voltage) tripping of the circuit breaker (shunt-trip device), a circuit breaker suitable for isolation in accordance with IEC 60947-2:2016+COR1:2016+A1:2019 shall be provided to prevent the contact from welding in the closed position.

The following circuits need not be disconnected by the supply disconnecting device:

— lighting circuits for lighting needed during maintenance or repair;

— plug and socket outlets for the exclusive connection of repair or maintenance tools and equipment (e.g. hand drills, test equipment);

— undervoltage protection circuits that are only used for automatic tripping in the event of supply failure;

— circuits supplying equipment that should normally remain energized for satisfactory operation [e.g. temperature-controlled measuring devices, product (work in progress) heaters, program storage devices];

— control circuits for interlocking.

Where these circuits are not disconnected by the supply-disconnecting device, such circuits shall be provided with their own disconnecting device.

As an exception, auxiliary devices may be equipped with supply-disconnecting devices as follows:

a) a plug/socket combination for a machine with a rated current not exceeding 16 A and a total power rating not exceeding 3 kW;

b) a plug and socket-outlet or an appliance coupler for a flexible cable supply (e.g. reeled, festooned) to a mobile machine under the following conditions:

   1) it shall not be possible to connect or disconnect a plug and socket-outlet or an appliance coupler, without breaking capacity, during load conditions;

   2) the plug and socket-outlet or the appliance coupler shall be so connected that the part connected to the incoming supply is that which is protected to at least IP2X or IPXXB.

Where a plug/socket combination with breaking capacity is used, it shall have a breaking capacity of at least the rated current of the machine at rated voltage. Where a plug/socket combination is used for disconnection under overload (e.g. locked rotor), the rating should be at least locked rotor current. In addition, these auxiliary devices shall have a separate on/off switch for starting and stopping movement.

5.4.3.3 Installation

Electrical devices and conductors shall be installed in such a way as to prevent damage from mechanical stress and environmental influences.

5.4.3.4 Insulated single-core conductors

For insulated single-core conductors connected between two terminals inside an enclosure (for example, a switch cabinet), the conductor identification number or letter may be omitted if, for example

— it is identified by colour in accordance with IEC 60204-1:2016+AMD1:2021; or

— the conductors are secured in position (for example by using comb-type wire fixation) in such a way that there is no confusion of conductors when changing electric components.

5.4.3.5 Testing of electrical equipment

All electrical equipment shall be designed such that it will withstand the testing specified in IEC 60204-1:2016+AMD1:2021.

5.4.3.6 Measuring devices

Measuring devices shall be in accordance with IEC 61010-1:2010+COR:2011+A1:2016, modified+A1:2016/COR1:2019.

5.4.4 Working platforms, access stairs, passageways, fixed ladders and raised workplaces

5.4.4.1 General requirements

The means of access and passageways to working areas shall be in accordance with the requirements of ISO 14122-1:2016, ISO 14122-2:2016, ISO 14122-3:2016 and ISO 14122-4:2016. For infrequently used working areas, the exceptions specified in 5.4.4.2 shall apply.

The usable width of machine gangways shall be at least 0,5 m. For gangways fitted at a height of more than 0,3 m, adequate means of access shall be provided.

NOTE The reader can determine the effects of mathematical conversion and rounding when converting from SI units to other units.

5.4.4.2 Exceptions for infrequently used platforms and access stairs

5.4.4.2.1 General

As an exception to the requirements of 5.4.4.1, infrequently used platforms and access stairs shall be in accordance with the requirements of 5.4.4.2.2 to 5.4.4.2.6.

5.4.4.2.2 Ergonomics

Ergonomic principles as specified in ISO 14122-2:2016 shall be considered in the design of such access platforms.

EXAMPLE The following are examples of measures by which this can be achieved:

— sufficient number of handholds, part of which can be reached from the reference level;

— mobile platforms;

— permanently fixed and hinged platforms.

5.4.4.2.3 Footstep dimensions

5.4.4.2.3.1 General

Footstep dimensions should be kept as uniform as possible throughout the system.

When one or more footsteps are provided, one or more handles shall also be provided.

The size of platforms used infrequently for stepping or short-term standing shall be at least 200 mm × 200 mm.

5.4.4.2.3.2 Single footsteps

For single footsteps (fixed or hinged), access levels may be permanent platforms or gangways. The following dimensions shall apply:

— normal step height ≤ 300 mm;

— maximum step height 500 mm;

— minimum width (for 1 foot) 200 mm;

— minimum width (for 2 feet) 300 mm;

— minimum depth 300 mm.

5.4.4.2.3.3 Multiple steps

Where multiple steps (fixed or hinged) are needed, the reference level shall have an effective width of at least 500 mm. The following dimensions shall apply:

— maximum height of upper footstep 1 200 mm;

— maximum height of intermediate steps 300 mm;

— minimum depth of footstep 200 mm;

— maximum height without railing 1 200 mm.

5.4.4.2.4 Handle dimensions

Where handles are required, the following dimensions shall apply (see Figure 27):

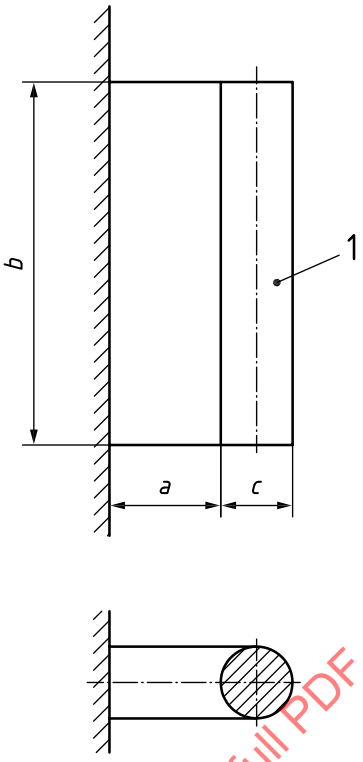
— minimum handle clearance 40 mm;

— minimum handle length 110 mm;

— minimum handle diameter 20 mm;

— maximum handle diameter 50 mm.

Dimensions in millimetres



Key

1 handle

a handle clearance ($a \geq 40$ mm)

b handle length ($b \geq 110$ mm)

c handle diameter ($20 \text{ mm} \leq c \leq 50$ mm)

Figure 27 — Handles for infrequently used access platforms

5.4.4.2.5 Hinged platforms

Hinged platforms shall be secured against unintended movement and shall be easy to position.

Hinged platforms between 0,5 m and 1,6 m high (the height is considered to be the maximum distance a person can fall from the hinged platform) shall be provided with at least one handrail. Where a handrail is not feasible and practical, a handhold shall be provided. For hinged platforms above 1,6 m high, the requirements of 5.4.4.1 shall apply.

Hinged platforms are generally provided in areas where space limitations prevent fixed platforms with handrails. Wherever feasible, the design of the platform should provide operators with sufficient support for ascending to or descending from the platform, as well as protection from falling off the platform.

5.4.4.2.6 Mobile hand-operated platforms

Mobile hand-operated platforms provided between stationary machine units do not require any fall-off protection on the machine side if the clearance between machine and platform does not exceed 200 mm (see Figure 28). For platforms more than 1,5 m high where the clearance exceeds 70 mm, toe plates shall be provided as minimum protection.

Dimensions in millimetres

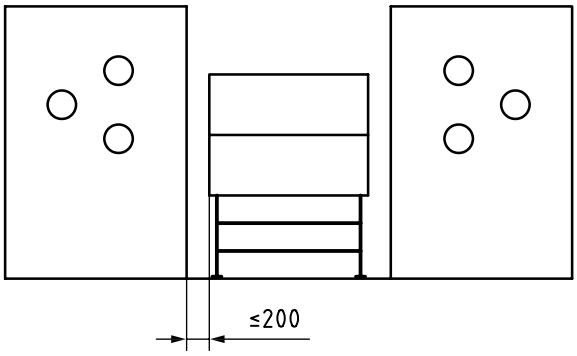


Figure 28 — Mobile platform

5.4.4.3 Platform, gangway and step surfaces

Platform, gangway and step surfaces shall be slip resistant in accordance with ISO 14122-2:2016.

EXAMPLE By using profiled metal plate.

Plates of material with a low slip-resistance capability (e.g. glass) fitted in access floors to allow the operator to observe the production process are permissible if they are fitted at a distance of at least 200 mm from the nearest fall-off edge (e.g. access stairs), and the accessible area of such materials does not exceed 18 000 mm^2 with a maximum width of 90 mm.

As an exception to the design load requirements of ISO 14122-2:2016, calculations or tests of plates of such material should be conducted to verify that a static load of 1 500 N applied to an area of 50 mm × 50 mm in the centre of such material will not lead to damage. The area being tested shall not include the metal frame surrounding the glass or other transparent area.

5.4.4.4 Access stairs and passageways

Access stairs and passageways shall have a clear height for passage of at least 2 m. If, for construction reasons, this height cannot be maintained, the protruding parts shall be padded and provided with hazard markings.

The maximum pitch angle on access stairs shall be 45°.

In some cases, higher pitch angles may be allowed depending on the results of a risk analysis (see Annex C).

Where stairs with pitch angles between 20° and 45° are used, the height of one flight of stairs should not exceed 3 m. Only where spatial restrictions exist may the height of one flight be a maximum of 4 m. Stairs with a total height of more than 4 m shall be fitted with an intermediate platform; the flight above the platform shall have a maximum height of 3 m. The platform should be at least 800 mm long where possible, but shall in no case be less than 600 mm.

NOTE 1 The user can determine the effects of mathematical conversion and rounding when converting from SI units to U.S./Imperial units.

The clear width of walkways and stairs shall be minimum 600 mm.

NOTE 2 When justified by the risk assessment and restrictions due to the machinery or environment, the free width can be reduced to no less than 500 mm if:

— the working platform or walkway is used only occasionally, and

— the reduction is made only for a short distance.

5.4.4.5 Extended use raised workplaces

Raised workplaces at which personnel spend an extended period of time should have a clear working area of at least 1,5 m^2 per person and a width of at least 1 m unless this inhibits ergonomic requirements (e.g. handling of objects).

5.4.4.6 Infrequently used workplaces

For infrequently used working areas that cannot be accessed by stairs, secured ladders may be used if the access height does not exceed 2 m. Toe plates and intermediate rails on railings are not required if the falling height is less than 2 m.

5.4.4.7 Railings, toe plates and self-closing gates

Railings with handrails, intermediate rails, toe plates or self-closing gates shall satisfy the requirements specified in ISO 14122-3:2016.

Where the difference in height does not exceed 1,6 m, a toe plate is not required if

— the respective level is not required for taking up auxiliary means required for production reasons, and

— operational intervention below that level is not required under the intended use.

In such cases, the intermediate rail shall be centred between the hand rail and the platform floor.

5.4.5 Stability

5.4.5.1 Unforeseeable changes of position

Machines and their elements shall be designed and equipped to be stable and to ensure that no unanticipated changes of position can occur; i.e. so that they do not fall over and are not capable of being unintentionally moved by vibration, wind pressure, impact or other foreseeable external forces or internal dynamic forces (inertial forces, electrodynamic forces, etc.).

Means for preventing unanticipated changes of position include the following:

a) adequate size of the base;

b) low centre of gravity;

c) adequate means for anchoring;

d) adequate design of wheels on track-mounted assemblies.

If this cannot be accomplished by design, then stability shall be obtained by special safety measures. Such special safety measures can include, but are not limited to, the following:

— restriction of the movements of parts of the machine;

— warning indicators or alarms if stability is endangered;

— provision of interlocks to prevent tipping;

— anchoring the machine securely to a foundation.

Both static and dynamic stability shall be considered. If special safety measures are required, a warning shall be provided on the machine and/or in the instruction handbook.

5.4.5.2 Unintended travel

Movable machines (machines on wheels) shall be safeguarded against unintended travel.

Measures to prevent unintended travel include, but are not limited to, the following:

— for machines with four wheels, providing a means of locking at least one wheel;

— for machines with two wheels and two caster wheels, providing a means of locking at least one caster wheel;

— for machines with four caster wheels, providing a means of locking at least two caster wheels.

EXAMPLE Self-locking gears are an example of automatic locking devices.

Unintended travel of machines on wheels and caster wheels with no brakes can occur on machines such as the following: small UV dryers; dampening water devices; inserting devices; jogging tables; sheet folding, riveting, stitching and eyeletting machines; strapping and tying machines; bundling and baling presses; printing slotters; rotary die-cutters and combined machines (in-line).

5.4.6 High contact temperatures

Contact temperatures of accessible heated parts on machines shall not be greater than the limit values specified in ISO 13732-1:2006.

NOTE Means to safeguard against contact with heated parts include the use of insulation, guarding or by distance.

5.4.7 Noise

Machines shall be designed and constructed so that risks from noise emission produced by the machines are reduced to the lowest practical level for that type of machine.

The general noise reduction measures according to ISO/TR 11688-1:1995 shall be observed. Specific noise reduction measures are, for example:

— correct application of noise absorption materials,

— covers;

— silencers;

— vibration dampening or

— selection of component materials or other methods as specified in ISO/TR 11688-1:1995.

NOTE 1 ISO/TR 11688-2:1998 provides useful information about noise generation mechanisms in machinery.

Noise emission measurements shall be carried out in accordance with the requirements specified in EN 13023:2003+A1:2010.

The level of noise emission shall be assessed with reference to comparative emission data for similar machinery. Annex D gives guideline values of emission sound pressure levels from German Berufsgenossenschaft (BG), and test results from Japan. The listed values in Annex D are low noise-emission values according to ISO 11689:1996, 7.4 and represent the state of the art in noise reduction technology for low-noise machines.

Significant sources of noise include – without claim to be exhaustive – gears, hydraulic devices, compressors, pumps, exhaust fans, blast air nozzles, suction devices (paper dust, trimmings), paper embossing; cutting, die-cutting, creasing of paper, board, paper grinders, cylinder rolling motion, paper

stops, separation of paper or board from the printing plate or printing forme, power transmission systems, pneumatic systems.

NOTE 2 Requirements relating to noise emission and protection of workers differ from country to country; national requirements can be consulted.

5.4.8 Radiation hazards

5.4.8.1 Laser devices incorporated in machinery

Laser devices incorporated in machinery shall be in accordance with the requirements of ISO 11553-1:2020 and IEC 60825-1:2014. The equipment shall be provided with fixed or interlocking guards in order to prevent access to positions where laser radiation emission is above the Category 1/1M limit values as specified by IEC 60825-1:2014 for the intended use of the machine.

During repairs, it can be necessary for trained personnel to operate the machine for short periods of time without fixed or interlocking guards. If this requires access to positions where laser radiation emission is above the Category 1 limit values, additional safety measures shall be taken in accordance with IEC 60825-1:2014.

If a category 1M laser is accessible during its intended use or during repair, the following warning shall be attached and the safe use shall be described in the instruction handbook:

"Laser category 1M according to IEC 60825-1:2014 Laser radiation: Do not view directly with optical instruments"

NOTE 1 Examples of laser devices include laser exposing devices, laser gravure equipment, laser cutting devices, etc.

NOTE 2 Means of additional safety measures include, but are not limited to, providing instruction to personnel regarding the use of personal protective equipment.

NOTE 3 For user information, see 8.3.

5.4.8.2 Ultraviolet irradiance

The radiation emission level of ultraviolet radiation emitted by machinery shall not exceed Category 1 as set out in EN 12198-1:2000+A1:2008, Annex B, Table B.2 for all workplaces where persons may be exposed to radiation as intended. According to EN 12198-1:2000+A1:2008, Clause 6, measurement and risk assessment of radiation emission is required.

In EN 12198-1:2000+A1:2008, Annex B, Table B.2, the effective UV irradiance in the spectral range 180 nm to 400 nm is limited to $E_{eff} \leq 1 \times 10^{-3}$ W/m^2 for Category 1. In the risk assessment, the intensity and duration of the radiation exposure shall be considered.

A lower maximum duration of exposure can be expected for equipment intermittently emitting UV, for example, where the emission of radiation is interrupted for procedural reasons in the preparatory phase of the exposing operation (feeding of the copy, travel to required position).

5.4.8.3 Ozone hazards caused by UV radiation

Every attempt shall be made at the design stage to eliminate hazards due to ozone creation by UV radiation. If the design cannot completely eliminate ozone creation, exposure to air containing ozone shall be prevented.

NOTE Measures for reducing ozone emission include low-ozone UV dryers, provision of exhaust equipment, or provision of adequate purification systems to filter out the ozone.

On UV continuous flow drying devices, any hazards caused by the build-up of ozone shall be prevented.

EXAMPLE By using devices with low ozone radiation or by providing exhaust systems that are designed such that they act as much as possible on the source of radiation.

Radiators shall be operated only when the exhaust system is switched on. The function of the exhaust system shall be monitored.

Failures in the exhaust system shall cause automatic stopping of the substrate feeding system (such as feeders on sheet-fed printing presses) or machine motion shall be stopped (such as on web-fed rotary printing presses). It shall be ensured that the drying device stops automatically after the drying of the substrate (such as the last sheet) is finished. The control system for monitoring the function of the exhaust system shall be in accordance with PL c of ISO 13849-1:2023 or SIL 1 of IEC 62061:2021.

5.4.9 Stationary knives

The cutting edge of a stationary knife blade (a knife that does not move during use) shall be guarded.

Safeguards shall be provided to prevent contact with stationary knife blades that can be tilted, even when they are not in working position.

5.4.10 Doctor blades

In general, doctor blades shall be safeguarded as stationary knife blades (see 5.4.9).

For operational reasons, it is not always possible to protect the doctor blade in the swung off position against contact.

NOTE In general, doctor blades in their working position are in a safe position due to the kind of installation.

The instruction handbook shall give advice of the necessity of wearing cut-resistant gloves during changing of doctor blades and when working in the vicinity of doctor blades which are in the swung off position.

5.4.11 Rotary tools

On rotary tools, both the in-running nips and the part of the peripheral area that is not used for the process shall be protected against contact by personnel. Preference shall be given to guards that do not have to be removed for tool change. The requirements of 5.3 shall be satisfied.

EXAMPLE Examples of rotary tools include circular cutters, perforating knives, perforating tools, rotary slitting tools, rotary bending tools, circular saws.

Split rotary tools shall be securely fastened to the tool carrier.

5.4.12 Transport and storage of hazardous tools

Devices shall be provided that prevent injuries caused by the hazardous tools of machines during their transport and storage. This requirement also applies to an individual tool that forms part of an assembly.

EXAMPLE Knives are an example of a “hazardous tool”. Knife boxes are an example of a “device”.

5.4.13 Protruding machine parts

Machine parts that unavoidably protrude, causing a collision hazard, shall be padded and provided with a yellow-black marking.

5.4.14 Handwheels and cranks

Handwheels and cranks shall be so designed that they do not automatically rotate during machine motion.

EXAMPLE One means of preventing automatic rotation is to decouple the handwheels and cranks by spring force.

5.4.15 Oxidizers, incinerators or thermal cleaning plants

Hazards associated with oxidizers, incinerators and thermal cleaning plants shall be prevented or, where this is not possible, reduced.

NOTE For guidance, see EN 12753:2005+A1:2010[8], NFPA 86:2018[58] and EN 746-1:1997+A1:2009[35].

Information on methods for reducing residual risks associated with these hazards shall be provided in the instruction handbook.

5.4.16 Protection against crushing and shearing hazards

5.4.16.1 Force limitation of power-driven machine parts

Power-driven travel of movable components (e.g. guards) shall not create any significant mechanical hazards.

This shall be achieved by limiting the force of the component movement by:

a) 50 N or less where the likely contact surface of the movable component is a blunt edge or projection and there is no risk of cutting or stabbing injuries; or

b) 150 N or less where the likely contact surface of the movable component is a plane such that there is no risk of a crushing injury.

However, if there is a crushing or shearing hazard for the head, power-driven travel of movable components shall be permitted only with a hold-to-run control.

5.4.16.2 Reel unwinding, rewinding devices

On devices with movable parts, all hazard zones where the risk of crushing exists from automatic movements shall be safeguarded according to the distances and gaps defined in ISO 13857:2019 and ISO 13854:2017. Risk of crushing exists between movable parts such as lifting arms, material reel and devices for acceleration, cutting and gluing, or in connection with fixed parts such as side frames, connecting bars or floor.

5.4.16.3 Pile turners and reel turners

On pile turners and reel turners, the crushing point between the floor and load-lifting member (lifting fork, pile carrier plate, pallet) or paper pile shall be safeguarded by the following.

a) Where hold-to-run control is being adopted as a safety measure, pile descent shall only be done in the hold-to-run control mode with a maximum speed of 5 m/min. Unintended access to the hazard zone shall be prevented by providing a sufficient distance between the location of the hold-to-run control and load-lifting member, or by providing a foot guard. The hazard point shall be in the operator's view from the location of the hold-to-run control. Hazard points on the far side of the paper pile are considered to be in the operator's view if the pile height, including load lifting member, does not exceed 1,4 m in the lowest position.

b) Electro-sensitive devices used for safeguarding a hazard zone with crushing points between the floor and the load-lifting member shall satisfy the requirements of 5.7.6 and 5.7.7 Hand approach

speeds according to ISO 13855:2010 need not be taken into account where the descent speed is not more than 5 m/min.

On hydraulic and pneumatic lifting equipment of pile turners and reel turners, a pilot-operated (unblockable) check valve shall be provided directly on the lifting cylinder if there is the possibility of uncontrolled gravity falling of the lifting device in the event of hose breakage or leakages.

The load-lifting device shall be designed and constructed such that it can withstand a static load of 1,25 times the maximum load capacity without permanent deformations or apparent defects. It shall be able to withstand a dynamic test with 1,1 times the maximum load under normal operating conditions. On pile lifting and lowering devices, the breaking strength of steel sprocket chains shall be at least four (4) times the admissible static load.

On pile turners and reel turners that are not exclusively operated in the hold-to-run control mode, an emergency stop pushbutton shall be provided on each control station.

5.4.17 Contact with hazardous substances

Means shall be provided to prevent personnel from coming into contact with, or inhaling, hazardous substances such as solvents, solvent mist and dust. Any personal protection measures required shall be described in the instruction handbook.

5.5 Release from hazardous situation

Means shall be provided for the release of persons in the event of entrapment.

NOTE Examples of release mechanisms include the following:

— provisions for moving some elements by hand or with the use of a tool;

— reversing the direction of the machine;

— opening the entrapment space.

Where means for manual movement are provided, indication of the direction of rotation should be provided near such means to assist in the release of persons.

5.6 Control zones

5.6.1 General

A system can consist of a multitude of machines and control systems. These can be divided into one or more subsystems creating “control zones” governing machine motion or non-motion for separate portions of the complete system. Small control zones can be used for independent operation. In other cases, these control zones may be combined to form a larger control zone.

5.6.2 Purpose of zone configuration

Generally, the purpose of zone configuration is to avoid the situation where actuating an emergency stop device in one zone stops motion in all zones. However, it is possible to configure the system such that an emergency stop device would affect all motion zones of the system (see 5.7.2.5.1.2).

Each control zone shall have a safety signalling system as specified in 7, if the overall view of the personnel by the operator is obstructed or communication between operating personnel is difficult within that control zone.

5.6.3 Control stations in control zones

The requirements of ISO 13850:2015 shall be met, this includes the stop/safe function.

Each control zone shall also have a control station as described in 5.8.

5.7 Controls

5.7.1 General

This subclause addresses specific controls that shall meet the criteria put forth in this document. The system may have other controls not specified in this document, but such additional controls shall not interfere with the function of those specified, nor shall their function be liable to be confused with the function of those specified.

5.7.2 Manual control devices

5.7.2.1 General

The requirements in this subclause apply to the following safety related functions:

— starting of hazardous movements (e.g. access to the hazard zones if an interlocking guard is open);

— reset function of area protection.

Manual control devices shall be designed and located so that:

— their arrangement prevents any unintended actuation;

— they are clearly visible and identifiable, and appropriately marked where necessary;

— they can be safely operated without hesitation or loss of time and without ambiguity (e.g. by the adoption of a standard layout of controls to reduce the possibility of error when an operator changes from one machine to another of similar type having the same pattern of operation);

— their location (for pushbuttons) and their movement (for levers and handwheels) are consistent with their effect;

— their actuation directly initiates the response of an electro-mechanical contact;

— the operating element allows cognitive operation by ensuring that the operating element moves on a defined path when actuated. This path is such that it gives the operator a tactile perception without any additional equipment and thus gives a direct feedback about its successful actuation.

NOTE 1 This feedback can be supplemented with further visual or acoustic signals.

NOTE 2 For the above-mentioned reasons, touch-sensitive control devices (TSCD) are not suitable.

Constraints due to the necessary or anticipated use of personal-protection equipment (such as footwear, gloves, etc.) by personnel during the operation of control devices shall be taken into account.

A stop control device shall be placed near each start control device. Where initiating motion is performed by means of a hold-to-run control device, a separate stop/safe pushbutton or emergency stop device shall be provided if there is a risk that the hold-to-run control device will fail to stop the hazardous motion when it is released.

Control devices shall be located outside the hazard zones, except for certain control devices such as emergency stop devices, teach pendant, etc., which, of necessity, are located within a hazard zone.

As far as possible, control devices (especially start control devices) shall be located so that the operator can see the elements being controlled when actuating the control device.

Control devices shall be designed or protected so that their effect, where a risk is involved, cannot occur without intentional operation.

Control switches for starting and stopping machine motion and their operating elements shall satisfy the requirements of IEC 60204-1:2016+AMD1:2021.

For emergency stop devices, the requirements of ISO 13850:2015 and IEC 60204-1:2016+AMD1:2021 shall be satisfied.

NOTE 3 If symbology is used, the symbol can be as defined in ISO/TR 15847:2008.

If manual control devices are mounted on portable control stations, the specific technical requirements of 5.8.3 shall also be satisfied.

5.7.2.2 Types of manual control devices

5.7.2.2.1 Flush control devices

Flush control devices shall be flush with their respective collars or with their adjacent surfaces.

5.7.2.2.2 Guarded control devices

Guarded control devices shall utilize raised collars or borders that extend beyond the surface of the control device to protect the control device from inadvertent actuation.

5.7.2.2.3 Mushroom-head and palm-type pushbuttons

Mushroom-head and palm-type pushbuttons shall protrude at least 9 mm beyond their respective collars. They shall also protrude above the actuators of adjacent unguarded, non-stop function control devices. The head of the mushroom-head or palm-type pushbuttons shall be at least 25 % larger than the surrounding pushbuttons and have a minimum diameter of 28 mm (see Figure 29).

NOTE The intent is to make these pushbuttons more prominent than surrounding pushbuttons.

a) Mushroom-head pushbuttons **b) Palm-type pushbuttons**

Figure 29 — Types of emergency stop and stop/safe pushbuttons

5.7.2.3 Colours for manual control devices

Colours used for control devices shall be as specified in Table 2.

Although Table 2 indicates both required and preferred implementations, for the purpose of promoting safety through uniformity in the industry, manufacturers are encouraged to use the preferred colours for the control as specified in Table 2.

The colour of the controls, illuminated or non-illuminated, shall be as specified in IEC 60204-1:2016+AMD1:2021, and shall be uniform throughout the system. If illuminated controls are used in conjunction with personnel warning lights, they shall be distinct in design and/or location so as not to be confused with personnel warning lights.

Table 2 — Colours for manual control devices

Control	Required	Preferred	Remarks
Emergency stop device	red on yellow background	—	—
Stop/safe pushbutton	red	—	—
Other motion stop	grey, black, white or red	black	red preferred in U.S.
Run	black, white, grey or green	black	—
Forward inch	black, white or grey	grey	—
Reverse inch	black, white or grey	black	—
Forward/Reverse inch	black, white or grey	black	used with a selector switch
Ready	black, white or grey	black	—
Reset	blue	—	—
Speed limit	black, white or grey	black	used primarily on newspaper presses
Plate position (or comparable control)	black, white or grey	grey	—
Automatic faster/resume	black, white or grey	—	used primarily on platen presses
Programmed position	black, white or grey	—	used primarily on platen presses
Other motion-initiating controls	black, white or grey	—	—

NOTE In some countries, there can be national regulations for the use of colour of controls, indicators or warning lights.

5.7.2.4 Markings

Requirements shall meet those in IEC 60204-1:2016+AMD1:2021, 10.2.2 and 16.3.

5.7.2.5 Functions, operations and mechanical specifications of manual control devices

5.7.2.5.1 Emergency stop

5.7.2.5.1.1 Emergency stop function

The emergency stop function shall satisfy the requirements of ISO 13850:2015 and IEC 60204-1:2016+AMD1:2021.

NOTE 1 Instructions for safety functional aspects of drives [e.g. Safe Stop 1 (SS+), Safe Torque Off (STO), Safe Brake Control (SBC) of a Power Drive System (PDS)] are given in IEC 61800-5-2:2016.

The emergency stop function shall override all other functions in all operating modes of the machine but shall not disable any system designed to release trapped persons as defined in 5.5. It shall not be possible for any start command (intended, unintended or unexpected) to be effectuated until the emergency stop function has been manually reset.

The emergency stop function shall be designed so that after the actuation of the emergency stop device, either of the following occurs:

a) all hazardous motion of all devices in the system is stopped as quickly as possible, without creating an additional hazard; or

b) all hazardous motion of the device(s) in the control zone is stopped as quickly as possible, without creating an additional hazard. In this case, it shall be readily apparent through labelling, marking, warning lights or other means (including training) which devices will be affected by the actuation of the emergency stop device.

The emergency stop function shall not be bypassed.

The emergency stop function shall not be used as a substitute for protective measures and other safety-related devices but should be designed for use as a backup measure.

The emergency stop function shall not impair the effectiveness of protective devices or of devices with other safety-related functions. For this purpose, it can be necessary to ensure the continuing operation of auxiliary equipment such as braking devices.

5.7.2.5.1.2 Emergency stop devices

The design of emergency stop device, including functional aspects, shall be in accordance with IEC 60204-1:2016+AMD1:2021 and ISO 13850:2015.

NOTE Instructions for the construction of emergency stop devices with mechanical latching function are given in IEC 60947-5-5:1997+A1:2005+A2:2016.

Touch sensitive control devices shall not be used for emergency stop functions.

5.7.2.5.1.3 Emergency stop function and auxiliary devices

For auxiliary devices built into a system that requires an emergency stop device according to this document, the emergency stop devices on the system shall function in accordance with the requirements of 5.7.2.5.1.2.

The emergency stop function shall be designed so that after the actuation of the emergency stop device, either:

— all hazardous motion of all devices in the system is stopped as quickly as possible, without creating an additional hazard; or

— all hazardous motion of the device(s) in the control zone is stopped as quickly as possible, without creating an additional hazard. In this case, it shall be readily apparent through labelling, marking, warning lights or other means (including training) which devices will be affected by the actuation of the emergency stop device.

5.7.2.5.2 Stop/safe pushbutton

This document does not require that a stop/safe pushbutton be provided. However, if provided, it shall meet the provisions of this subclause. The stop/safe pushbutton shall meet the same design and control requirements of an emergency stop pushbutton, except it does not need to stop the machine as fast as possible.

Category 2 stop according to IEC 60204-1:2016+AMD1:2021 is permitted provided the stopped condition is monitored and upon detection of failure of the stopped condition, power shall be removed without creating a hazardous situation.

NOTE The stop/safe function is required in the United States and can be required in other countries.

Stop/safe functions shall be controlled only by the use of a stop/safe pushbutton as specified in this document. Touch sensitive control devices shall not be used for stop/safe functions.

A stop/safe pushbutton shall be clearly distinguishable from an emergency stop pushbutton, if separate pushbuttons are used for each function. Stop/safe pushbuttons not designed to function also as an emergency stop pushbutton shall not have a yellow background.

After a stop/safe pushbutton is released, the machine shall not automatically start. The operator shall go through the normal starting sequence in order to initiate machine motion. If personnel warning lights are used, the light shall be red.

Single-point failure of the latching component shall not result in the machine automatically reverting to the ready condition.

The latching mechanism shall be designed such that a person is prevented from unintentionally releasing the pushbutton to the ready condition.

This pushbutton may be designed to be used also as an emergency stop pushbutton. If so used, it shall be in accordance with the requirements for both the stop/safe and emergency stop functions and pushbuttons as defined in this document.

All stop/safe pushbuttons shall be operational and shall not be bypassed.

The stop/safe function shall be designed so that, after actuation of the stop/safe pushbutton, all hazardous motion of the machine(s) in that control zone is stopped without creating an additional hazard. When the pushbutton is latched in the depressed position, machine motion is prevented and the machine is placed in the safe condition.

The stop/safe function shall override all other motion functions, except the emergency stop function, and shall not be bypassed.

The stop/safe function shall not impair the effectiveness of protective devices or of devices with other safety-related functions.

For this purpose, it can be necessary to ensure the continuing operation of auxiliary equipment such as clutches or braking devices.

5.7.2.5.3 Other motion stop control devices

Actuating a stop control device as defined in this subclause shall stop machine motion at least in the motion zone, or part of the motion zone, with which it is associated. A stop control device need not stop motion in the entire control zone. When the stop is complete, the motion zone affected shall be in the fault or ready condition.

This stop control device shall not be used for the stop/safe or emergency stop functions.

Where, for operational reasons, a stop control category 2 according to IEC 60204-1:2016+AMD1:2021 is used for the operational stop and there is a risk of injury in case of an unexpected start up, the stop condition shall be monitored. In the case of a fault detection of the stop condition, a reaction intended to stop the arising movement is mandatory.

The required Performance Level for the monitoring depends on the risk after the unexpected start up (see 5.10.1.2).

5.7.2.5.4 Run control device

The run control shall be a momentary-contact control.

Activating a run control initiates continuous (maintained run) machine motion as described in 5.7.3.2 or places the machine in an armed condition such that the machine is running at zero speed. However, auxiliary equipment that is part of the system can be running at zero speed and/or can be in the armed condition.

NOTE A system can have any number of run controls, labelled differently, allowing the machine to run at different particular or set speeds, including speeds which are slower than production speed.

See Clause 7 and Annex A for the requirements of a warning period in systems using either a personnel warning-light signalling system or an area-light warning signalling system.

Once motion is established, the machine shall run continuously at the speed set by the speed-setting control.

5.7.2.5.5 Inch control (jog)

5.7.2.5.5.1 Forward inch control

The forward inch control shall be a momentary-contact control that functions as described in 5.7.3.1, and moves the system in a forward direction.

The control shall be designed and mounted so as to minimize inadvertent operation. One means of achieving this is by the use of a double-push activation as described in 5.7.3.1 b).

During the permissive period, the machine shall respond promptly to any inch control and shall continue to operate as long as the control is depressed at limited speed, or until the displacement limitation specified in 5.3.6 is reached. The machine shall stop when the control is released.

Motion with an inch control while one or more guard(s) is/are open shall be permitted in accordance with 5.3.5.1 and 5.3.6.

5.7.2.5.5.2 Reverse inch control

A reverse inch control shall be a momentary contact guarded control. The control shall be designed and mounted to minimize inadvertent operation. One means of achieving this is using a double-push activation as described in 5.7.3.1 b).

During the permissive period, the machine shall respond promptly to any inch control and shall continue to operate as long as the control is depressed at limited speed, or until the displacement limitation specified in 5.3.6 is reached. The machine shall stop when the control is released.

Motion with an inch control while one or more guard(s) is/are open shall be permitted in accordance with 5.3.5.1 and 5.3.6.

A reverse inch control initiates system motion at inch speed in a reverse direction as specified in 5.7.3.1.

5.7.2.5.5.3 Forward/reverse inch control

A forward/reverse inch control shall be a single device incorporating a two-position selector and a momentary-contact control, which initiates system motion as defined in 5.7.3.1.

With the selector switch in the forward position, the inch control shall function in accordance with 5.7.2.5.5.1. With the selector switch in the reverse position, the inch control shall function in accordance with 5.7.2.5.5.2.

5.7.2.5.6 Reset

The control used for the reset function shall be a momentary-contact control that resets a tripped circuit.

Motion controls shall not be enabled until all faults are cleared, all interlocks are made and all emergency, stop/safe pushbuttons are released. The reset function shall not automatically enable motion controls unless these conditions have been satisfied.

If these conditions have been satisfied, activating the reset function shall place the machine in the ready condition. Activating a reset control shall not initiate a warning period or machine motion.

5.7.2.5.7 Other motion-initiating controls

Other controls used to initiate motion of the main drive shall be momentary-contact controls.

EXAMPLE An example would be a blanket cylinder positioning control or a re-synchronization control.

5.7.2.5.8 Selector switches

A multiple-position selector switch may be used in conjunction with another motion control. However, it shall not be used as an alternative or substitute for the controls defined in this document.

5.7.3 Initiating machine motion

5.7.3.1 Initiating machine motion at inch speed

Machine motion at inch speed may be initiated for a machine at standstill by either of the following methods:

a) activating the inch or reverse inch control through the warning period; or

b) sequential (double-push) activation of the same inch or reverse inch control.

Regardless of which implementation is chosen, it shall be uniform throughout the system.

5.7.3.2 Initiating continuous machine motion (run)

Continuous machine motion may be initiated by any one of the following methods:

a) double-push activation of the run-control device;

b) actuation of the run, the slower or the faster control with the inch control at the same control station while the machine is in the ready condition will initiate a warning period, followed by machine motion at a speed set by a speed setting device; or

c) actuation of the run, the slower or the faster device with the inch device at the same control station while the machine is in the permissive period initiates machine motion at a speed set by a speed setting device without going through an additional warning period if all hazards are protected.

Regardless of which implementation is chosen, it shall be uniform throughout the system.

5.7.4 Hold-to-run controls

A hold-to-run control shall require continuous actuation of the control device(s) to achieve operation.

5.7.5 Two-hand controls

5.7.5.1 General

Two-hand controls as safety devices are acceptable only if all hazardous movement stops when one manual control device is released. The hazardous movement shall come to a stop in a time period that, taking into consideration the hand-approach speed, ensures there is no hazard for the operator. The hand-approach speeds specified in ISO 13855:2010 shall be taken as a basis (see 5.3.6 for hold-to-run devices designed as two-hand controls).

5.7.5.2 Two-hand controls on cables

Mobile two-hand control device used for make-ready and troubleshooting shall be permissible if, from the place of operation of the two-hand control, it is possible to observe the hazard points and hazard zones. In these circumstances, ISO 13855:2010 is not applicable. Cables shall have sufficient strength to withstand any anticipated mechanical stresses and be provided with tension-relief measures.

NOTE This measure only affords protection to the person that activates the device.

5.7.5.3 Two-hand controls safeguarding hazard points

Where two-hand controls are used to safeguard hazards that are infrequently accessed, hydraulic/pneumatic two-hand controls shall meet the requirements specified for Type IIIA, and electric/electronic two-hand controls shall meet the requirements specified for Type IIIB of ISO 13851:2019.

Where two-hand controls are used for safeguarding hazard points requiring routine and regular access, hydraulic/pneumatic two-hand controls shall satisfy the requirements specified for Type IIIB, and electric/electronic two-hand controls shall satisfy the requirements specified for Type IIIC of ISO 13851:2019.

5.7.6 Electro-sensitive protective devices

Electro-sensitive protective devices (ESPDs) shall satisfy the requirements of Type 2 of IEC 61496-1:2020 and IEC 61496-2:2020, only if after risk assessment the safety requirement is PL c/SIL 1 or less.

For PL d/SIL 2 and above Type 4, ESPD's of IEC 61496-1:2020 and IEC 61496-2:2020 shall be used.

For safety functions which shall satisfy PL d of ISO 13849-1:2023, light barriers Type 2 can be used if for the entire safety function (including the control system) PL d can be reached by the related PFH_d values.

Where electro-sensitive protective devices are used to prevent whole-body access to hazard zones, and fixed photoelectric beams are used, there shall be a minimum of three arranged at a height of 300 mm, 700 mm and 1 100 mm. When the arrangement is measured from the access level, due to the structural tolerances at the location of installation, the permissible tolerance for the arrangement is ± 35 mm.

The further requirements of ISO 13855:2010 shall be met.

5.7.7 Pressure-sensitive mats, pressure-sensitive bumpers, trip devices

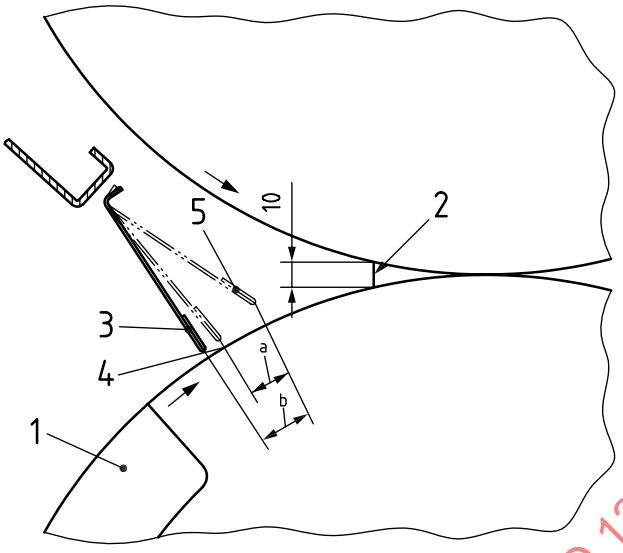
Pressure-sensitive mats and pressure-sensitive bumpers shall satisfy the requirements of ISO 13856-1:2013.

Trip devices shall satisfy the requirements of ISO 13856-2:2013 and be in accordance with at least PL d of ISO 13849-1:2023 or SIL 2 of IEC 62061:2021.

Trip devices, and their related signal processing, which safeguard routine and regular access to a hazard point on a manually-fed device shall be in accordance with at least PL e of ISO 13849-1:2023 or SIL 3 of IEC 62061:2021. Where pressure-sensitive mats are used to safeguard routine and regular access to a hazard point on a manually-fed device it shall be in accordance at least PL d of ISO 13849-1:2023 or SIL 2 of IEC 62061:2021.

Pressure-sensitive bumpers and trip devices shall function such that the hazardous movements, which they are safeguarding, shall be stopped before personnel can reach the hazard (see Figure 30).

Dimensions in millimetres



Key

1 cylinder gaps
2 nip point
3 normal guard position
4 tripped guard position
5 maximum guard position
a Maximum stopping distance of hazardous motion.
b Maximum length of movement of trip device.

Figure 30 — Trip devices

5.7.8 Braking devices and clutches

5.7.8.1 Switch-off of braking device

The braking device may be switched off only by either of the following:

a) use of a maintained-contact control, if the disengagement of the brake is interlocked with the hazardous machine movement; or

b) use of a momentary-contact control which, when released, re-engages the braking device.

Braking devices are switched off, for example, when powered machines operate in a non-powered mode.

5.7.8.2 Clutch or brake failure on single-stroke machines

On single-stroke operation machines, clutch or brake failures shall not cause any hazardous movement.

NOTE A single-stroke operation machine is one that completes a single cycle, then pauses before the next cycle is initiated. For example, trimmers, paper drills, and bundling machines are single-stroke operation machines. A guillotine cutter is the most common example of a single-stroke machine.

5.8 Control stations

5.8.1 General

The use of a control station is determined by the desired functions to be performed at its location. The contents and location (if necessary) of control stations are specified in 5.8.2.

In a control station, controls shall be arranged so that either the emergency stop or stop/safe pushbutton is readily accessible from an operating position.

NOTE In most cases, the emergency stop or stop/safe pushbutton is located closest to the operating position.

The respective order of controls should be uniform throughout the system. When a control station is located with another (non-motion control) station, the functions of the control station shall be distinctly set apart from the non-motion functions by spacing, marking or framing.

When a control station contains both a motion control and a stop/safe pushbutton or emergency stop pushbutton, the stop/safe or emergency stop function shall affect at least the same machine or group of machines within the system affected by the motion control in that control station.

When a control station includes both emergency stop and stop/safe pushbuttons, the emergency stop pushbutton shall be distinctly set apart by spacing, marking or framing.

5.8.2 Control station location

Control stations shall be securely affixed and readily accessible for normal make-ready and other routine, repetitive operations integral to the operation of the equipment and which require control of the main drive motor(s).

EXAMPLE Routine, repetitive operations are clearing jams, adjusting operations, etc.

Every operating position of the system shall have a control station within arm's reach of the operator and shall be placed so that the operator does not have to reach past moving parts.

Within a hazard zone, the only motion-initiating control permitted shall be a forward inch-control device and a reverse inch-control device, as specified in 5.3.6, 5.7.2.5.5.1 and 5.7.2.5.5.2.

All controls on a control station shall be visible and accessible from the associated operating positions. If a control station is movable (not portable), the station shall be physically supported by a suitable means other than the electrical wiring.

5.8.3 Portable control stations

Portable control stations shall meet the same criteria as other control stations. In addition, cables shall be protected from damage and shall not pose an additional hazard to personnel. If a portable control station can extend into a hazard zone in which the guard could be closed while the operator is within the hazard zone, that control station shall not permit motion at a speed greater than that specified in 5.3.6.

Portable control stations shall meet the requirements of IEC 60204-1:2016+AMD1:2021. The e-stop function and the e-stop push button shall meet the requirements of ISO 13850:2015.

The performance level (see ISO 13849-1:2023) of the operator control functions on the portable control stations shall be the same, as defined in the other requirements of this document for fix mounted operator control stations with a direct cabling.

If portable control stations are used to initiate potentially hazardous movements with one or more open guards it shall be ensured by technical measures that any hazard zones, such as motion zone, are visible to the operator from the place of operation.

NOTE Technical measures to achieve this are for example: limited length of the cord, RFID-System for the registration of the device in the operating zone.

A cableless motion control without an emergency stop device or stop/safe pushbutton shall only be active if all safety devices are in a safe condition.

An automatic stop shall be activated when correct control signals are not received, including loss of communication between the portable control station and the machinery control system.

5.9 Remote access

Due to the complex nature of remote access, any remote access of equipment shall ensure that personnel are not exposed to hazardous motion or additional risk of injury, and shall not in any way compromise the safety systems defined in this document and machine-specific parts of ISO 12643 series.

NOTE Protocols and procedures are agreed to between the affected parties involved to ensure the integrity of the safety system during, and upon completion of, remote access.

5.10 Safety-related control systems

5.10.1 Hydraulic, pneumatic, electric and electronic control systems

5.10.1.1 General

After switching on any kind of energy supply or a restoration of the energy supply after an interruption a safe machinery status shall be established by the control system as follows:

— safe stand still of all hazardous movement, manual controlled start by the operator is required,

— all ESPDs are in the status "interrupted"; a manual reset is mandatory, and

— all other functions with a hazardous potential are switched off (e.g. UV dryer); switching on by the operator is mandatory.

Safety-related parts of control systems shall be in accordance with ISO 13849-1:2023 and ISO 13849-2:2012 and include, for example, circuits carrying emergency stop commands, electric interlocking circuits, limiters of displacement or operating speed on hold-to-run controls.

The design of hydraulic systems shall be in accordance with the requirements of ISO 4413:2010; the design of pneumatic systems shall be in accordance with the requirements of ISO 4414:2010.

5.10.1.2 Performance levels

The performance level (PL) or safety integrity level (SIL) requirements of safety-related parts of control systems depend on the result of risk assessment (see Table 3).

In the hydraulic/pneumatic control system, the safety-related parts shall satisfy at least a required performance level PL c of ISO 13849-1:2023. If there is a risk of irreversible injuries or head or torso injuries then the required performance level is PL d of ISO 13849-1:2023.

In the electric/electronic control system, the safety-related parts shall meet the required safety levels of ISO 13849-1:2023 (performance level PL) or IEC 62061:2021 (safety integrity level SIL), based upon the potential extent of harm, as follows.

a) If a malfunction of the safety related control system can cause irreversible injuries, or if there is a risk of head or torso injuries, PL d or SIL 2 is required.

b) If the hazards caused by a malfunction of the safety related control system are minor (no irreversible injuries), PL c or SIL 1 is required.

Table 3 shows the performance level classification of general applications. Classifications differing from those shown in Table 3 can be specified in the machine-specific parts of ISO 12643 series, as a result of risk assessment of the function relative to the specific device, machine or system.

Table 3 — Performance level classifications

Safety function	PL b SIL 1	PL c SIL 1	PL d SIL 2	PL e SIL 3	ISO 12643-1
Controls — General					
Requirements for hydraulic controls		x	x		5.10.1.2
Requirements for pneumatic controls		x	x		5.10.1.2
Requirements for electric/electronic/ programmable controls		x	x		5.10.1.2
Emergency stop		x	x		5.10.1.2 For every potential hazard the emergency stop, and stop/ safe function, shall meet at least the PL for the safety related parts of the control system required for the safety function provided for the same hazard.
Stop/safe for the prevention of unexpected start-up of drives		x	x		5.10.1.2 For every potential hazard the emergency stop, and stop/ safe function, shall meet at least the PL for the safety related parts of the control system required for the safety function provided for the same hazard
Electrically interlocked protective devices (limit switches)		x	x		5.3.5.3.2 Even If PL d is required, one position switch can be sufficient, if the requirements for the fault exclusion, according to ISO 13849-2:2012, is considered. 5.10.1.2
Modes of operation (e.g. hold-to-run, crawling speed)			x		5.10.1.2
	x[a]		x		5.3.6
Audible alarm/warning lights	x				Clause 7
Emergency stop upon low-voltage detection		x			5.10.3
Mutual interlocking of operation zones in the modes of operation (e.g. hold to run, crawling speed)	x				5.10.5
Residual pile monitoring system	x				5.10.4
Portable controls			x		5.8.3
Controls — Hand fed machines where the operator has routine and regular access to hazard points					
Requirements for hydraulic controls			x		5.10.6.2
Requirements for pneumatic controls			x		5.10.6.2
Requirements for electric/electronic/programmable controls				x	5.10.6.3 5.3.5.3.2 5.10.1.1

[a] Provided that safe speed reduction or limitation of displacement in accordance with ISO 13849-1:2023, PL d is ensured, the signal release for starting in hold-to-run mode or stopping may be effected by one single contact, if the further processing of signals of the hold-to-run switch/contact is done in accordance with ISO 13849-1:2023, PL d.

Is applicable if the hold-to-run mode is the only safety measure (for example, while the safety device is open).

Table 3 *(continued)*

Safety function	PL b SIL 1	PL c SIL 1	PL d SIL 2	PL e SIL 3	ISO 12643-1
Trip bars/pressure sensitive mats (bumpers)					
Pressure sensitive mats/trip bars			x		5.7.7
ESPDs		x	x		5.7.6, at least ESPD's of Type 2 according to IEC 61496-1:2020 and IEC 61496-2:2020 shall be used
Controls — Unwinding/Rewinding device					
Monitoring Reel unloading/loading area (chucking cones)			x		5.3.8.3
Monitoring of position of fences			x		5.3.8.4
Prevention of overwinding of reels			x		5.3.8.7
Prevention of ejection of reels			x		5.3.8.7
Guard interlocking at unwinding device			x		5.3.8.10.3
Ozone hazards caused by UV radiation					
Monitoring of ozone exhaust systems in continuous flow dryers		x			5.4.8.3 can be met using a standard PLC

[a] Provided that safe speed reduction or limitation of displacement in accordance with ISO 13849-1:2023, PL d is ensured, the signal release for starting in hold-to-run mode or stopping may be effected by one single contact, if the further processing of signals of the hold-to-run switch/contact is done in accordance with ISO 13849-1:2023, PL d.

Is applicable if the hold-to-run mode is the only safety measure (for example, while the safety device is open).

5.10.1.3 Automatic mode

For machinery functioning in automatic mode, the starting of the machinery, or restarting after a stoppage or a change in operating conditions, may be possible without intervention by the operator if this does not lead to a hazardous situation.

5.10.2 Electronic adjustable speed drives

On electronic adjustable speed drives, the control system shall be designed such that in the event a guard or safety device causes the machine to stop, either the main contactor will also be switched off or any other appropriate measure will be taken.

NOTE 1 "Safety devices" include, but are not limited to, emergency stop devices, electro-sensitive protective devices, and trip devices. "Other appropriate measures" include, but are not limited to, the application of a mechanical brake with a braking torque greater than the drive torque of the motor. An "additional control measure" is, for example, an electric/electronic device (timer) that switches off after a preset time.

On electronic adjustable speed drives which feed energy back into the electric circuit during stopping, appropriate control-related measures (in addition to pulse blocking) shall be taken to ensure that the main contactor is switched off no later than after the elapse of the normal stopping time, or any other adequate measure to that effect. During hold-to-run control operations, there is no need to disconnect the main contactor during release time.

NOTE 2 For example, on electronic adjustable speed drives, the speed of rotation of the motor is changed by shifting the supply voltage and/or frequency.

5.10.3 Cut-off of main energy source

When an emergency stop device is fitted with a main contactor that detects a low-voltage condition, the main contactor shall be in accordance with at least PL c of ISO 13849-1:2023 or SIL 1 of IEC 62061:2021, and shall disconnect the main power supply.

NOTE For example, opening the contact of the emergency stop device directly disconnects the power supply to the low-voltage tripping coil.

5.10.4 Residual-pile monitoring systems

A residual-pile monitoring system that is also used as a safety device shall be in accordance with at least PL b of ISO 13849-1:2023 or SIL 1 of IEC 62061:2021.

5.10.5 Unobserved unguarded hazard zones

When more than one interlocking guard is open and there are any unguarded hazard zones that cannot be observed from all operating positions, the circuits controlling mutual interlocking of safety devices that prevent machine motion under hold-to-run condition shall be in accordance with at least PL b of ISO 13849-1:2023 or SIL 1 of IEC 62061:2021. The interlocking can be controlled by computer.

For areas that are not visible from the operating position, see 5.3.7.1.

All other safety-related parts of control systems, including limiters of displacement or operating speed on hold-to-run controls and mechanisms for preventing machine motion under continuous-run condition, shall be in accordance with the requirements of 5.10.1.

5.10.6 Increased control system requirements for hand-fed machines

5.10.6.1 General

For those hand-fed machines where the operator has routine and regular access to hazard points at which the operator's hands can come into contact with the tools or the path of tool movement, the additional requirements of 5.10.6.2 to 5.10.6.5, shall apply.

NOTE For example, this can apply to certain platen and screen presses, guillotine cutters, three-knife trimmer with manual infeed and hand-fed label punching machines.

5.10.6.2 Hydraulic/pneumatic control system

The safety-related parts of the hydraulic/pneumatic control system shall be in accordance with PL d of ISO 13849-1:2023.

5.10.6.3 Electric/electronic control system

The safety-related parts of the electric/electronic control system shall be in accordance with at least PL e of ISO 13849-1:2023 or SIL 3 of IEC 62061:2021.

5.10.6.4 Main contactors

Main contactors shall be redundant. Faults in the main contactors shall be detected and shall lead to shutdown.

5.10.6.5 Systems using electronic braking

Systems using electronic braking shall have, as back-up, an additional electro-mechanical or pneumatic-mechanical brake that works independently of the electronic brake. In the condition "power off" or "safe

torque off" or other comparable conditions, a mechanical braking device shall prevent a dangerous movement.

NOTE 1 For example, electronic brakes exist on electronic drives where the braking effect is caused by energy being fed back into the circuit.

NOTE 2 Dangerous movements can be caused for example by energy stored in springs or elevated loads.

5.11 Ergonomics and labelling of indicators and actuators

Unless otherwise specified in this document, the ergonomic design and labelling requirements relating to indicators and actuators shall be in accordance with the requirements as specified in IEC 61310-1:2007, IEC 61310-2:2007 and IEC 61310-3:2007.

6 Verification of the safety requirements and/or protective/risk reduction measures

The Table 4 describes the methods used to verify if the safety requirements and/or measures described in Clause 5 are complied with.

Table 4 — Verification of safety requirements and/or protective/risk reduction measures

Subclause number	Title	a) Calculation	b) Visual inspection	c) Measurement	d) Testing
5.3.2	Guards				
5.3.2.1	Guard types and travel				
5.3.2.1.1	Types of guards		x		
5.3.2.1.2	Power-driven travel of movable guards			x	x
5.3.2.1.3	Protection against gravity falls of guards		x		x
5.3.2.2	Guard dimensioning, positioning and safety distances		x	x	
5.3.2.3	Guard openings		x	x	
5.3.3	In-running (in-going) nips		x		
5.3.4	Guarding in-running nips		x	x	x
5.3.5	Interlocks		x		x
5.3.5.1	Opening an interlocking guard			x	x
5.3.5.2	More than one interlocking guard open				x
5.3.5.3	Interlock design		x		
5.3.6	Hold-to-run mode		x	x	x
5.3.7	Protective measures for accessible hazard zones				
5.3.7.2	Fence-type enclosures		x	x	
5.3.7.3	Electro-sensitive protective devices	x			x
5.3.7.4	Pressure-sensitive mats, pressure-sensitive bumpers, trip nip bars	x			x
5.3.7.5	Auxiliary devices that act as guards		x		x
5.3.8	Guarding reel unwinding, rewinding and transport devices				
5.3.8.1	Hazard point between reel and belt		x	x	

Table 4 *(continued)*

Subclause number	Title	a) Calculation	b) Visual inspection	c) Measurement	d) Testing
5.3.8.2	Drawing-in nips at reel unwinding and rewinding devices with support rollers or bearer drums		x	x	x
5.3.8.3	Requirements for chucking cones for manual reel loading and unloading		x	x	
5.3.8.4	Prevention of ejection of material reels (residual reel)		x	x	x
5.3.8.5	Hazard points by movement of lifting arms		x	x	x
5.3.8.6	Hazard points by rotating material reel		x	x	
5.3.8.7	Monitoring of circumferential speed of material reel	x	x		
5.3.8.8	Unintended lowering of raised arms of loaded material reel		x		
5.3.8.9	Transport of the material reel to the unwinding device and from the rewinding device		x	x	x
5.3.8.10	Hazard zone guarding of the entire reel unwinding and rewinding device				
5.3.8.10.1	Automatic reel loading systems	x	x		x
5.3.8.10.2	Manual reel loading systems		x	x	x
5.3.8.10.3	Safeguarding of the rear hazard zone		x		x
5.3.8.11	Reel rewinding device with contact/pressure roller				
5.3.8.11.1	Protective devices on reel rewinding devices with manual reel change		x	x	x
5.3.8.11.2	Protective devices at reel rewinding devices with automatic reel change		x	x	x
5.3.9	Threading of web material		x	x	x
5.3.10	General Requirements for feeding units and delivery units				
5.3.10.1	Pile lifting and lowering devices				
5.3.10.1.1	Static load test and dynamic load test			x	x
5.3.10.1.2	Breaking strength of steel link chains	x			
5.3.10.1.3	Movement limitation in case of component failure		x	x	x
5.3.10.1.4	Whole-body access below the pile carrier	x	x	x	x
5.3.10.1.5	Hazard points between the pile carrier and the place where the operator may stand	x	x	x	x
5.3.10.1.6	Safeguarding the upward movement of the pile carrier	x	x	x	x
5.3.10.2	Pile-changing devices for feeding and delivery units	x	x	x	x
5.3.10.3	Safeguarding of the separating elements when separating at the bottom of the pile		x	x	x
5.3.10.4	Safeguarding the separating elements during separation from the top of the pile		x	x	
5.3.10.5	Pull-in and forwarding wheels		x	x	
5.4	Requirements for protection against other hazards				
5.4.2	Fire and explosion protection				
5.4.2.1	Explosion protection				
5.4.2.1.1	General		x	x	
5.4.2.1.2	Avoidance of the formation of potentially explosive atmospheres		x	x	

Table 4 *(continued)*

Subclause number	Title	a) Calculation	b) Visual inspection	c) Measurement	d) Testing
5.4.2.1.3	Avoidance of effective ignition sources				
5.4.2.1.3.1	Determination of effective ignition sources		x	x	
5.4.2.1.3.2	Limiting the surface temperature			x	
5.4.2.1.3.3	Avoidance of ignition sources by non-electrical devices and equipment		x	x	
5.4.2.1.3.4	Avoidance of ignition sources by electrical devices and equipment		x		
5.4.2.1.3.5	Avoidance of electric sparks due to static electricity	x		x	
5.4.2.2	Fire protection		x		
5.4.3	Electrical equipment				
5.4.3.1	General		x		
5.4.3.2	Supply-disconnecting device		x	x	x
5.4.3.3	Installation		x		
5.4.3.4	Insulated single-core conductors		x		
5.4.3.5	Testing of electrical equipment			x	x
5.4.3.6	Measuring devices		x		
5.4.4	Working platforms, access stairs, passageways, fixed ladders and raised workplaces				
5.4.4.1	General requirements		x	x	
5.4.4.2	Exceptions for infrequently used platforms and access stairs		x	x	
5.4.4.2.1	General		x	x	
5.4.4.2.2	Ergonomics		x		x
5.4.4.2.3	Footstep dimensions		x	x	
5.4.4.2.3.1	General		x	x	
5.4.4.2.3.2	Single footsteps		x	x	
5.4.4.2.3.3	Multiple steps		x	x	
5.4.4.2.4	Handle dimensions		x	x	
5.4.4.2.5	Hinged platforms		x	x	
5.4.4.2.6	Mobile hand-operated platforms		x	x	
5.4.4.3	Platform, gangway, and step surfaces		x	x	x
5.4.4.4	Access stairs and passageways		x	x	
5.4.4.5	Extended use raised workplaces		x	x	
5.4.4.6	Infrequently used workplaces		x	x	
5.4.4.7	Railings, toe plates and self-closing gates		x	x	x
5.4.5	Stability				
5.4.5.1	Unforeseeable changes of position	x	x		
5.4.5.2	Unintended travel		x		
5.4.6	High contact temperatures			x	
5.4.7	Noise			x	
5.4.8	Radiation hazards				
5.4.8.1	Laser devices incorporated in machinery		x	x	x

Table 4 *(continued)*

Subclause number	Title	a) Calculation	b) Visual inspection	c) Measurement	d) Testing
5.4.8.2	Ultraviolet irradiance		x	x	x
5.4.8.3	Ozone hazards caused by UV radiation			x	
5.4.9	Stationary knives		x		
5.4.10	Doctor blades		x		
5.4.11	Rotary tools		x		
5.4.12	Transport and storage of hazardous tools		x		
5.4.13	Protruding machine parts		x		
5.4.14	Handwheels and cranks		x		x
5.4.15	Oxidizers, incinerators or thermal cleaning plants	x	x	x	
5.4.16.1	Force limitation of power-driven machine parts			x	
5.4.16.2	Reel unwinding, rewinding devices		x	x	
5.4.16.3	Pile turners and reel turners	x	x	x	x
5.4.17	Contact with hazardous substances		x		
5.5	Release from hazardous situation		x		x
5.6	Control zones		x		
5.7	Controls				
5.7.2	Manual control devices		x		
5.7.2.2	Types of manual control devices				
5.7.2.2.1	Flush control devices		x		x
5.7.2.2.2	Guarded control devices		x		x
5.7.2.2.3	Mushroom-head and palm-type pushbuttons		x		x
5.7.2.3	Colours for manual control devices		x		x
5.7.2.4	Markings		x		x
5.7.2.5.1.1	Emergency stop function		x		x
5.7.2.5.1.2	Emergency stop devices		x		x
5.7.2.5.1.3	Emergency stop function and auxiliary devices		x		x
5.7.2.5.2	Stop/safe pushbutton		x		x
5.7.2.5.3	Other motion stop control devices		x		x
5.7.2.5.4	Run control device		x		x
5.7.2.5.5	Inch control (jog)		x		x
5.7.2.5.5.1	Forward inch control		x		x
5.7.2.5.5.2	Reverse inch control		x		x
5.7.2.5.5.3	Forward/reverse inch control		x		x
5.7.2.5.6	Reset		x		x
5.7.2.5.7	Other motion-initiating controls		x		x
5.7.2.5.8	Selector switches		x		x
5.7.3	Initiating machine motion		x		x
5.7.4	Hold-to-run controls		x		x
5.7.5	Two-hand controls		x	x	x

Table 4 *(continued)*

Subclause number	Title	a) Calculation	b) Visual inspection	c) Measurement	d) Testing
5.7.6	Electro-sensitive protective devices		x	x	x
5.7.7	Pressure-sensitive mats, pressure-sensitive bumpers, trip devices		x	x	x
5.7.8	Braking devices and clutches		x		x
5.8	Control stations				
5.8.1	General		x		x
5.8.2	Control station location		x		x
5.8.3	Portable control stations		x		x
5.9	Remote access		x		
5.10	Safety-related control systems		x		x
5.11	Ergonomics and labelling of indicators and actuators		x		

7 Signals and warning devices

7.1 General

A warning system shall be required for systems in which the overall visibility of personnel to the operator is obstructed, or if communication between operating personnel is difficult.

NOTE 1 This condition can exist, for example, on systems if

— the machine length exceeds 7 m;

— there is more than one machine unit/section, and the height of the machine unit/section, measured from floor level, is greater than 1,6 m;

— the system includes machines on different floors.

An audible alarm as described in 7.2, or an area-light warning system as described in Annex A, shall be used. A combination of audible alarm and area warning lights may be used. Use of personnel warning lights without an audible alarm is not permitted except as noted in 7.2.6.

A personnel warning system with an audible alarm as defined in 7.2.1, 7.2.2, and 7.2.3, or an area warning light system as defined in Annex A should be used. If a personnel warning light system is used, it shall include the requirements defined in 7.2.4, 7.2.5 and 7.2.6.

NOTE 2 In some countries, such as in the United States, the use of personnel warning lights is required by ANSI B65 standards [44][45][46][47] unless the area-light warning system is used.

Warning signals shall occur before the initiation of machine motion and shall be clearly recognized and differentiated from all other signals used.

When a system with multiple machine actuators is configured into multiple control zones, there shall be, at a minimum, a common warning system activated independently by each motion zone. Unique audible alarms (with different audible characteristics) for each control zone are optional.

NOTE 3 If personnel warning lights are used, their independent operation is optional (see 5.6).

7.2 Audible warning system

7.2.1 Audible alarm

The audible warning system shall consist of an audible alarm, a warning period and a permissive period. Different audible characteristics can be used to distinguish between different machines.

The audible signal shall be capable of being perceptible in the noise environment of the machinery in accordance with ISO 7731:2003.

7.2.2 Warning period

The warning period shall end not less than 2 s after depressing a motion control. Machine motion shall not occur during the warning period. Machine motion may occur at the end of the warning period.

The audible alarm shall sound throughout the entire warning period.

For warning systems equipped with personnel warning lights, the red personnel warning lights shall have a discernible flash. The light should flash more than once for the warning to be discernible.

At the end of the warning period, one of the following two procedures is permitted:

a) The following "double-push" sequence is preferred.

   At the end of the warning period, machine motion will occur as the result of releasing a motion control during or after the warning period, and reactivating a motion control during the permissive period.

   The warning period shall be cancelled by depressing a stop/safe pushbutton or by opening a safety circuit.

b) Alternatively, machine motion will occur as the result of holding a motion control through and beyond the warning period.

   The warning period shall be cancelled by depressing a stop/safe pushbutton or by opening a safety circuit.

   The warning period can also be cancelled by releasing a motion control before the end of the warning period. If the warning period is cancelled by releasing a motion control prior to the completion of the warning period, the machine shall return to the ready condition.

Although option b) is not considered to be unsafe, option a) is preferred for the purpose of consistency.

7.2.3 Permissive period

The permissive period shall be a period that shall be initiated after completion of a full warning period. A permissive period shall also be initiated when an inch or reverse-function control is released after machine motion has been established.

If the "double push" is used to initiate motion (e.g. a motion button is activated during the warning period, released, and reactivated during the permissive period), the permissive period shall not exceed 6 s. Each successive inching operation during a permissive period initiates a new permissive period.

If a single push to initiate motion at inch speed is used (e.g. an inch button is depressed and held through the warning period), machine motion at inch speed will occur at the end of the warning period. When the inch button is released, a permissive period not exceeding 4 s shall be initiated. During this permissive period, an inch button can again be depressed and motion initiated at inch speed without going through an additional warning period. Each successive inching operation during a permissive period initiates a new permissive period.

If an inch button is not pressed during the permissive period, motion shall not be permitted without going through a new warning period.

It is permissible to use a combination of double-push and single-push to initiate inch and run.

For example, for production reasons it can be preferable to use the double-push system to initiate inch, but a single-push system to initiate run.

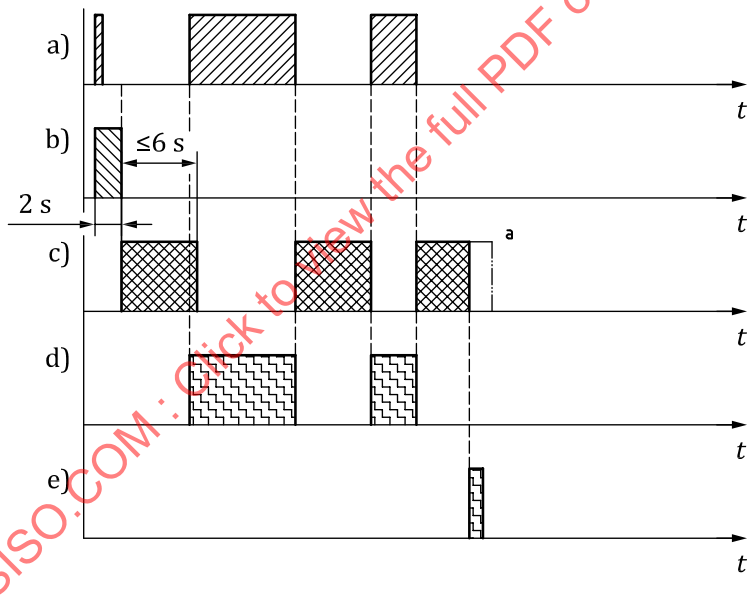
The permissive period is cancelled by depressing a stop or stop/safe pushbutton, or by breaking a safety circuit.

A change in direction of machine motion at inch speed within the same permissive period is permitted without the initiation of a new warning period (see Figure 31).

If the optional personnel warning light system is used, the warning lights shall operate as specified in 7.2.4

NOTE The permissive period allows for successive inch or reverse operations without each being preceded by a warning period.

Dimensions in seconds



Key

a) inch operation (forward or reverse)
b) warning period and audible alarm
c) permissive period
d) machine motion
e) stop, stop/ safe, breaking a safety circuit
t time, seconds
[a] Cancellation of the permissive period.

Figure 31 — Audible warning system with double-push sequence

7.2.4 Optional personnel warning lights with audible alarm

If a personnel warning-light system is used, red and green lights shall be used to indicate the ready/ running and the safe conditions, respectively; for example, the red colour shall indicate a ready or running condition and the green colour shall indicate a safe condition. Personnel warning lights shall

be clearly visible from any control station. These personnel warning lights shall be distinct from any machine status lights.

A green personnel warning light shall be illuminated only when the associated stop/safe function has been initiated, indicating a safe condition.

In a vertical orientation, the red personnel warning light shall be above the green personnel warning light. In a horizontal orientation, the red personnel warning light shall be to the left of the green personnel warning light. Horizontal orientation shall not be permitted if personnel warning lights mounted in a horizontal orientation could be viewed from both sides, resulting in a reversal of the colour sequence.

NOTE The restrictions for horizontal orientation are to ensure that personnel, especially those with visual impairments such as colour blindness, can expect the colour sequence to always be the same.

The personnel warning lights and audible alarms shall be in accordance with the requirements specified in Table 5.

Table 5 — State of warning devices for audible warning system with personnel warning lights

Warning-device status	Machine condition					
	Stop/safe	Ready or fault	Warning period	Permissive period	Machine motion	Armed
Green light	ON[a]	OFF	OFF	OFF	OFF	OFF
Red light	OFF	ON	FLASH	FLASH	ON/OFF[b]	ON/FLASH[c]
Audible alarm	OFF	OFF	ON	OFF[d]	OFF	OFF/PULSE[c]

[a] One option for indicating the operating location of the stop/safe pushbutton is when the green personnel warning light of the operating location flashes, while the green personal warning light(s) is/are continuously on at all other operating locations of the other stop/safety pushbuttons (continuous light, no flashing).

[b] If the red personnel warning light is off when the machine is in motion, first it shall be on until at least 30 s after the machine reaches production speed before turning off. Machines at which no lights are illuminated shall be considered to be in an unsafe condition.

[c] Either condition is permitted.

[d] See Annex A for an exception if the permissive period exceeds 6 s.

7.2.5 Optional personnel warning lights for automatic set-up operations

Red lights may be used to warn of the machine motion of an automatic set-up system. The light shall flash for 2 s prior to the initiation of the automatic sequence and during the entire period of automatic motion. These personnel warning lights shall be distinct from any machine-status lights.

7.2.6 Optional personnel warning lights for auxiliary equipment having armed status

If auxiliary equipment connected to a system is capable of running at zero speed (armed condition), this equipment may use personnel-warning lights to indicate the armed condition, the running condition, and the safe condition. A separate audible alarm is not required on the auxiliary equipment.

When this auxiliary equipment is used in a stand-alone mode, if overall visibility of personnel by the operator of the equipment is not obstructed, warning signals as specified in 7.1 are not required.

7.3 Area-light warning system

An area-light warning system, as specified in Annex A, may be used instead of the audible warning system defined in 7.2.

8 Information for use

8.1 Safety signs

Safety signs shall meet the requirements of ISO 3864-1:2011, ISO 3864-2:2016, ISO 3864-3:2012 and ISO 7010:2019.

NOTE In some countries, national or regional regulations can exist for the use of safety signs.

For all significant hazards that cannot be avoided or safeguarded by design or protective measures, appropriate safety signs or labels must be provided at or near the hazard location.

8.2 Specific requirements for machine markings

8.2.1 Markings and signs/labels

Machinery shall be provided with the markings, signs/labels as specified in ISO 12100:2010, and IEC 60204-1:2016+AMD1:2021.

8.2.2 Additional requirements for pile lifting and lowering devices, pile turners and reel turners

On pile lifting and lowering devices (feeding and delivery devices), pile turners and reel turners, the following additional information shall be clearly marked:

— permissible operating pressure on pneumatically driven pile lifting and lowering devices;

— permissible operating pressure on hydraulically driven pile lifting and lowering devices inasmuch as the pressure generator is not a component part of the pile lifting and lowering device;

— maximum carrying capacity;

— sign saying that riding on the device is forbidden for format sizes larger than 2,5 m^2.

8.2.3 Machinery fitted with laser equipment

On machinery fitted with laser equipment, the classification of the equipment shall be indicated together with any warnings in accordance with IEC 60825-1:2014, where required.

8.2.4 Machinery with UV radiation emission

On machinery where UV radiation of at least Category 1 as specified in EN 12198-1:2000+A1:2008 is expected, the category number as specified in EN 12198-1:2000+A1:2008 and the type of radiation shall be indicated.

8.2.5 Machines having hot parts

Extra warnings shall be provided on machines with hot machine parts, including hot pipes that are an integral part of the machine, if the surface temperature is above 65 °C and if the surfaces are not protected against contact by insulation or additional guards.

NOTE Refer to ISO 13732-1:2006 for further information relating to the assessment of burn hazards.

8.2.6 Feeding belt

A safety sign warning against access shall be provided on the feeding belt. A warning shall also be included in the instruction handbook.

8.3 Contents of instruction handbook

8.3.1 General

Each machine shall be accompanied by an instruction handbook, in a language which can be easily understood by end-users in the country of destination and as required in the country concerned.

NOTE 1 Guidance on contents of instruction handbook can be found in Annex E and ISO 20607:2019. Basic specifications are given in ISO 12100:2010.

Instruction handbooks shall be structured in accordance with ISO 12100:2010.

The instruction handbook shall provide the following information on noise emission values determined according to EN 13023:2003+A1:2010:

— the A-weighted emission sound pressure level L_{pA} and its uncertainty K_{pA}, where L_{pA} exceeds 70 dB(A). Where the L_{pA} does not exceed 70 dB(A), this fact shall be indicated;

— the A-weighted sound power level L_{WA} and its uncertainty K_{WA}, where the A-weighted emission sound pressure level L_{pA} exceeds 80 dB(A);

— the C-weighted peak sound pressure level L_{pCpeak}, where this exceeds 130 dB.

See Annex E for examples of instruction handbook layout.

In addition, the instruction handbook(s) shall, where required:

a) describe the protective measure, if any in addition to 8.2.5, to prevent accidental contact with hot machine parts with a surface temperature of more than 65 °C;

b) indicate those areas on the machine suitable for fitting suction devices in order to avoid the emission of hazardous gases, vapours and combustible dusts and shall specify the required suction capacity;

c) contain an indication that in the case of possible dust accumulations in the machine, the user shall determine by means of a risk assessment (considering specific conditions of use and the materials), how and how often the machines shall be cleaned in order to reliably prevent fire hazards and the development of explosive atmospheres; as well as a statement that the cleaning intervals for dusty surfaces inside the machine are adapted to the dust accumulation so that deposits of combustible dusts in a layer thickness of 1 mm or greater are avoided;

NOTE 2 Zones in which higher dust occurrence can be expected are, for example folding devices, slitters and cross cutters, perforating units, cutting equipment, sheet delivery with anti-setoff powder application

d) describe any residual risks that cannot be excluded despite the safety measures provided and shall identify where special training is required and which personal protective measures (for example wearing protective gloves, eye protection, clothing and hearing protectors) are required;

e) provide information on hearing protection (recommend to wear for machines exceeding emission sound pressure level of 80 dB(A), required if 85 dB(A) is exceeded), low noise operating modes, noise control measures and on operator training on hearing protection. The instruction handbook shall specify that hearing protection shall be used when entering the noise enclosure of a machine.

f) provide information, regarding the use of personal protective equipment to provide sufficient protection against hazards from solvents and solvent vapours;

g) provide information about the residual risk where interlocking guards shall be opened for fault finding with the machine is operated in the hold-to-run mode. The handbook shall state that the person opening the guard and carrying out the work is required to ensure that there are no other persons in the hazard zone.

h) provide all information and instructions relating to safety requirements where it is anticipated that the machine or parts of the machine can be used in potentially explosive atmospheres;

i) provide an indication regarding minimising the amount of combustible/ flammable liquids that may be kept on or near the machine; The storage amount at the machine shall be limited to a shift supply and shall be taken into account for hazardous area classification;

j) contain an indication that preferably flammable working materials (e.g. washing liquids and cleaning agents) with a higher flash point should be used.

NOTE 3 See also ISO 80079-37:2016, 5.4 for lubricants, coolants and fluids.

k) point out that in areas where hazardous areas can occur, sufficient ventilation (air exchange rate) shall be taken into account;

l) give a warning in the installation instructions to place the machines at sufficient distances from elements of the building (the walls, pillars, etc.) such that persons avoid being crushed between them and the moving machine parts;

m) provide information about the requirements for interfaces connecting a machine to the preceding or following equipment and to external power supplies (operation of emergency stop control systems, overall system control, etc.);

n) give instructions for the proper handling and adjusting of guards;

o) provide information regarding the control of specific tools to authorized, competent and properly trained personnel;

NOTE 4 This can include tools used for opening and closing fixed guards.

p) provide information regarding the use of personal protective equipment when appropriate;

q) provide instructions for safe threading of the web for machines working with web material (roll laminators, coaters, feeding systems for case makers, etc.).

r) identify areas having stored and residual energy sources that are not controlled by the stop/safe pushbutton and require the use of devices or lockout/tagout, and the actions needed to control the energy sources.

s) indicate what safety signs are supplied by the manufacturer, their meaning, location on the machine, and replacement part number.

t) contain information regarding the safety-relevant service life.

NOTE 5 Mission time (safety-relevant service life) are according to ISO 13849-1:2023 or IEC 62061:2021.

8.3.2 Machines using combustible liquids

The instruction handbook for machines using liquids with a flash point below 60 °C shall contain the instruction that in the area of zone 1 and at least 1 m around the flooring shall be conductive or dissipative in order to prevent people becoming electrostatically charged.

NOTE A Zone 1 area is considered to be the area in which an explosive atmosphere consisting of a mixture of air with combustible substances in the form of gas, vapour or mists is likely to occur in normal operation occasionally.

When changing hoses and pipes used for combustible or explosive materials, the instruction handbook shall contain the instruction that the hoses and pipes shall be conductive and electrostatically grounded as required in 5.4.2.1.3.5.

8.3.3 Machines with cutting knives

The instruction handbook for machines with cutting knives shall contain information regarding total response time, in milliseconds, for all electronic and mechanical lag times associated with stopping the hazardous motion of a knife at any point in the cycle.

The handbook shall describe safe working practices for the changing of knives, including the means of safeguarding knife blades and the adjustment of knives in order to prevent hazards from exposed knife edges. The handbook shall give detailed instructions as to the removal of the knives using the tools and the knife covers supplied, and the subsequent storage in knife boxes.

8.3.4 Handling heavy machine parts

Where heavy machine parts need to be installed and removed regularly, necessitating the lifting of a load of at least 25 kg per person, the instruction handbook shall indicate the need for the user to provide adequate means of lifting and transport.

EXAMPLE Examples of machine parts that need to be installed and removed routinely include screen rolls, gravure cylinders, some rubber rolls, flexo forme cylinders, hoppers, feeders, etc.

8.3.5 Machines with automatic paper loading

The instruction handbook for machines with automatic paper loading shall describe the correct positioning of the paper supply for feeding to ensure safe working conditions. An example of this type of information is stating the distance and the angle between paper pile and feeding table.

8.3.6 Residual risks using ESPDs

The instruction handbook shall warn the user of any residual risks that can exist when using one or more ESPDs. The following conditions shall be covered by relevant notes:

a) risks occurring through intentionally defeating the bypass sequences;

b) movement of persons in areas where the view is obstructed by product or machinery;

c) intended use, and prohibited use, of the bypass function (top and bottom ESPD);

d) climbing over or crawling underneath the ESPD;

e) pressing a reset pushbutton and activating (or reactivating) the ESPD protection zone if a person is within the zone.

The documentation shall contain information regarding maintenance intervals and separate inspection and test notes for this safety equipment.

8.3.7 Pile turners and reel turners

The instruction handbook shall clearly state the maximum load capacity of pile turners and reel turners.

8.3.8 Pile carriers

The instruction handbook shall describe methods of applying a mechanical device during maintenance operations as a suitable means to ensure that lowering of the pile carrier plate is prevented.

8.3.9 Residual risk for hold-to-run speeds of above 10 m/min under two-hand control

Where it is required for production reasons to start machines with guards open under two-hand control with a speed of more than 10 m/min, a residual risk exists. The instruction handbook shall provide information to the operator to ensure that there is no other person in the hazard zone before operating the control.

8.3.10 Use of stroboscopes

Where the use of stroboscopes is required for fault-finding and troubleshooting, a residual risk exists if machines are required to run with very high hold-to-run speeds with guards open. The instruction handbook shall contain a warning to this effect, and shall also instruct the person operating the hold-to-run/two-hand control to ensure that there is no other person in the hazard zone before operating the control.

8.3.11 Reel rewinding unit with contact/pressure roller

The clamping devices on expansion shafts can produce trapping spots outside the core and/or material reel during the rotational movement. These trapping spots shall be safeguarded depending on the width of the core and/or material reel by the operator, for example, by fixing core caps.

The instruction handbook shall give information with reference to residual risks arising in connection with access to the nip from the side between the web and the material reel.

8.3.12 Machines with doctor blades

If work is carried out in the vicinity of the doctor blade, it shall be pointed out in the instruction handbook that, the doctor blade shall be swung to the working position. If this is not possible for operational reasons, appropriate cut-resistant gloves shall be worn in addition

Information on residual risks (cutting injuries) and the necessity of wearing appropriate cut-resistant gloves shall be given.

The safe changing of the doctor blade shall be described. The instruction handbook shall give advice of the necessity of wearing appropriate cut-resistant gloves during changing of doctor blades.

NOTE In general, doctor blades in their working position are in a safe position due to the kind of installation.

Annex A
(normative)

Area-light warning system

A.1 General

The area lights shall consist of white lights positioned about the machine in sufficient number and of adequate intensity so that when flashing OFF (dim) and ON (bright), the varying reflected intensity is apparent in the appropriate machine motion zone(s). Flashing operation shall have a period of 1 s or less with a duty cycle of 50 %.

The status of area warning lights shall be as specified in Table A.1.

A.2 Warning period

The warning period is initiated by clearing all stop/safe pushbuttons and ends not less than 2 s later. Actuation of a motion control prior to the completion of the warning period shall not induce machine motion. During the warning period, the area warning lights shall flash and a minimum of two complete flash cycles shall occur.

A.3 Permissive period

The permissive period is a period of not more than 6 s which is initiated after completion of a full warning period.

If, for operational reasons, it is necessary that the permissive period exceed 6 s, a permissive period of no more than 12 s is permitted.

Motion is initiated during the permissive period by actuation of a motion control.

A permissive period is also initiated when an inch or reverse function control is released after machine motion has been established.

The permissive period is cancelled by initiating a change in direction of machine motion or by depressing a stop/safe pushbutton under the following conditions.

— If the permissive period is cancelled by initiating a change in machine direction, a new full warning period shall be initiated automatically.

— If the permissive period is cancelled by depressing a stop/safe pushbutton, the machine is returned to the safe condition.

As an exception a change in direction of machine motion at inch speed within the same permissive period is permitted without the initiation of a new warning period provided all hazards are protected.

During the permissive period, the area warning lights shall flash.

When machine motion is established, the area lights shall be ON (bright).

At the end of the permissive period, the system shall automatically revert to a ready condition. The area warning lights shall be ON (bright).

NOTE The permissive period allows for successive inch or reverse operations without being preceded by a warning period.