INTERNATIONAL STANDARD

ISO 12643-1

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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

Reference number
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Foreword

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

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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

ISO 12643-1 was prepared by Technical Committee ISO/TC 130, *Graphic technology*.

This first edition of ISO 12643-1, together with ISO 12643-2, cancels and replaces ISO 12648:2006, which has been technically revised. This edition of ISO 12643-1, together with ISO 12643-3, cancels and replaces ISO 12649:2004, which has been technically revised.

ISO 12643 consists of the following parts, under the general title *Graphic technology — Safety requirements for graphic technology equipment and systems*:

— *Part 1: General requirements*

— *Part 2: Press equipment and systems*

— *Part 3: Binding and finishing equipment*

Introduction

During the development of this part of ISO 12643, existing relevant standards of other countries were taken into consideration. An effort has been made to take into consideration the requirements of many countries, recognizing that national standards or laws may dictate national requirements. In cases where it was known that there is a national requirement that differs from this part of ISO 12643, that has been noted.

This part of ISO 12643 was developed to harmonize the following U.S. and European safety standards:

— ANSI B65.1, *Graphic technology — Safety standard — Printing press systems*;

— ANSI B65.2, *Binding and Finishing Systems*;

— ANSI B65.3, *Safety standard — Guillotine paper cutters, mill trimmers, and integral handling equipment;*

— ANSI B65.4, *Safety standard — Three-knife trimmers, including rotary, and single- and multiple-knife trimmers*;

— EN 1010-1, *Safety of machinery — Safety requirements for the design and construction of printing and paper converting machines — Part 1: Common requirements;*

— EN 1010-2, *Safety of machinery — Safety requirements for the design and construction of printing and paper converting machines — Part 2: Printing and varnishing machines including pre-press machinery;*

— EN 1010-3, *Safety of machinery — Safety requirements for the design and construction of printing and paper converting machines — Part 3: Cutting machines*;

— EN 1010-4, *Safety of machinery — Safety requirements for the design and construction of printing and paper converting machines — Part 4: Bookbinding, paper converting and finishing machines*.

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

Part 1: General requirements

1 Scope

This part of ISO 12643 provides safety specifications for the design and construction of new machines used in printing press systems and in binding and finishing systems. It includes equipment used in a 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 listed in this part of ISO 12643 are applicable to the equipment covered by all parts of ISO 12643, unless otherwise noted. Requirements specific to press and binding and finishing equipment and systems, that are not included in this part of ISO 12643, are given in ISO 12643-2 and ISO 12643-3, respectively.

This part of ISO 12643 addresses recognized hazards specific to equipment and systems in the following areas:

— mechanical;

— electrical;

— slipping, tripping, falling;

— ergonomics;

— noise;

— radiation;

— fire and explosion;

— thermal;

— other emissions.

It is advisable that technologies not identified in this part of ISO 12643 incorporate the safety principles set forth herein in their design.

2 Normative references

The following referenced documents are indispensable for the application 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 8031, *Rubber and plastic hoses and hose assemblies — Determination of electrical resistance*

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

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

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

ISO 12100-1, *Safety of machinery — Basic concepts, general principles for design — Part 1: Basic terminology, methodology*

ISO 12100-2, *Safety of machinery — Basic concepts, general principles for design — Part 2: Technical principles*

ISO 12643-2:2007, *Graphic technology — Safety requirements for graphic technology equipment and systems — Part 2: Press equipment and systems*

ISO 12643-3:—[1)], *Graphic technology — Safety requirements for graphic technology equipment and systems — Part 3: Binding and finishing equipment*

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

ISO 13849-1:1999, *Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design*

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

ISO 13851, *Safety of machinery — Two-hand control devices — Functional aspects and design principles*

ISO 13852, *Safety of machinery — Safety distances to prevent danger zones being reached by the upper limbs*

ISO 13854, *Safety of machinery — Minimum gaps to avoid crushing of parts of the human body*

ISO 13855, *Safety of machinery — Positioning of protective equipment with respect to the approach speeds of parts of the human body*

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

ISO 14119:1998, *Safety of machinery — Interlocking devices associated with guards — Principles for design and selection*

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

1) To be published.

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

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

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

ISO/TR 15847:— [2], *Graphic technology — Graphical symbols for printing press systems and finishing systems, including related auxiliary equipment*

IEC 60079-1, *Electrical apparatus for explosive gas atmospheres — Part 1: Flameproof enclosures "d"*

IEC 60079-2, *Electrical apparatus for explosive gas atmospheres — Part 2: Pressurized enclosures "p"*

IEC 60079-5, *Electrical apparatus for explosive gas atmospheres — Part 5: Powder filling "q"*

IEC 60079-6, *Electrical apparatus for explosive gas atmospheres — Part 6: Oil-immersion "o"*

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

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

IEC 60079-14, *Electrical apparatus for explosive gas atmospheres — Part 14: Electrical installations in hazardous areas (other than mines)*

IEC 60079-18, *Electrical apparatus for explosive gas atmospheres — Part 18: Construction, test and marking of type of protection encapsulation "m" electrical apparatus*

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

IEC 60825-1, *Safety of laser products — Part 1: Equipment classification, requirements and user's guide*

IEC 60947-2, *Low-voltage switchgear and controlgear — Part 2: Circuit-breakers*

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

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

IEC 61010-1, *Safety requirements for electrical equipment for measurement, control, and laboratory use — Part 1: General requirements*

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

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

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

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

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2) To be published.

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

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

EN 1760-2, *Safety of machinery — Pressure sensitive protective devices — Part 2: General principles for the design and testing of pressure sensitive edges and pressure sensitive bars*

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

EN 13023, *Noise measurement methods for printing, paper converting, paper making machines and auxiliary equipment — Accuracy categories 2 and 3*

NFPA 79 [3)], *Electrical Standard for Industrial Machinery*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13849-1:1999 and the following apply.

3.1
actuator
part of the actuating system to which an external actuating force is applied

[IEV 441-15-22][24]

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

NOTE 2 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.

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

NOTE **Zero speed** (3.64) can be 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
authorized person
person identified by management as having special training or designated to act in specified situations

NOTE Examples of “specified situations” include:

— special tasks to be performed;

— the function of the adjustments in the work zone;

— proper operation of adjustments and controls;

3) Available from National Fire Protection Agency, Batterymarch Park, Quincy, Massachusetts, USA 02169-7471; www.nfpa.org.

— all types of hazards in the area where the task is to be performed;

— the application of equivalent, alternative protection to perform the task;

— improper actions that can cause injury and the consequences of those improper actions.

3.5
auxiliary device
mechanism or machine, either built-in or attached, used for the production process

3.6
barrier guard
guard (3.21) 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.

3.7
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.

3.8
Category 0 stop
uncontrolled stop
stopping by immediate removal of power to the **machine actuators** (3.29)

[IEC 60204-1]

3.9
Category 1 stop
controlled stop with power available to the **machine actuators** (3.29) to achieve the stop and then removal of power when the stop is achieved

[IEC 60204-1]

3.10
Category 2 stop
controlled stop with power left available to the **machine actuators** (3.29)

[IEC 60204-1]

3.11
continuous run
machine motion at a steady speed initiated by a momentary-contact control

3.12
control station
defined location containing one or more controls

3.13
control zone
control configuration of single or multiple machine motions using the same control devices

NOTE See Clause 8.

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, which include, but are not limited to, direct-motor drives;

— drives having stored energy, which include, but are not limited to, motor-flywheel-clutch drives and hydraulic-pneumatic drives

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

NOTE Adapted from ISO 12100-1:2003.

3.16
electro-sensitive protective device
ESPD
apparatus that detects the presence of a person or part of a person or object in a defined area, using any detection means including, but not limited to, photoelectric, light screen, ultrasonic, etc.

3.17
emergency stop device
manually actuated control used to initiate an **emergency stop function** (3.18)

NOTE Adapted from ISO 13850:1996.

3.18
emergency stop function
mechanism activated 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

3.19
exposing device
machinery used for creating images by exposing photo-sensitive material such as printing plates or printing formes

3.20
fixed guard
guard (3.21) 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

3.21
guard
physical barrier that restricts access to a significant hazard

3.22
hazard point
location of a hazard on a machine where a person can be injured

3.23
hazard zone
any area within and/or around machinery in which a person is exposed to risk of injury or damage to health

NOTE Adapted from ISO 12100-1:2003.

3.24
hold-to-run control
control that starts and maintains machine motion only as long as the control is activated

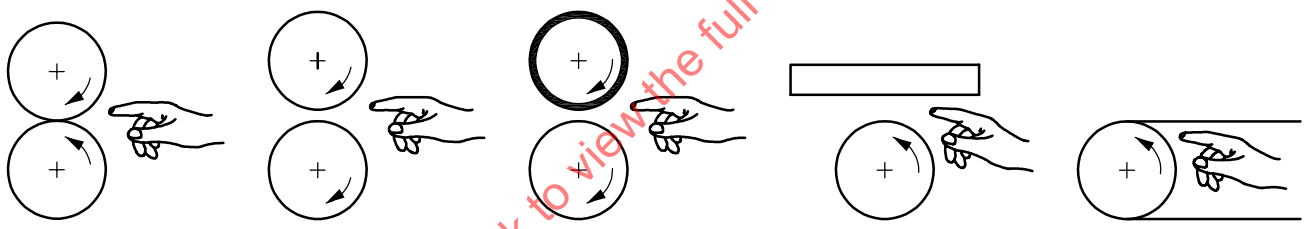
3.25
inch
jog
〈operation of machinery〉 machine motion requiring maintained activation engagement of a hold-to-run control and which will continue until the control is released or until a pre-determined displacement (limited inch) has been reached

3.26
infrequently used workplace
area in which an activity is carried out, such as observation, make-ready, jam clearing, minor servicing, crossing inserting hoppers or conveyer belts, etc., that is routine, repetitive, integral to (but not necessarily during) production, and done only on an occasional basis

3.27
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

See Figure 1.

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



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

Figure 1 — In-running nips

3.28
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

[IEC 60204-1]

3.29
machine actuator
power mechanism used to affect motion of a machine

[ISO 13850:1996]

3.30
maintained-contact control
control that remains in an open or closed state after its activation

3.31
maintenance
operation(s) required to assure that the machine remains in acceptable operating condition and that is/are usually performed when the machine is not available for production

NOTE Maintenance (for example, repairing or replacing broken, worn or damaged parts; performing lubrication; preventive servicing) is normally 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 generally performed with energy isolated, when possible.

3.32
make-ready
tasks 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.

3.33
manual control device
mechanism comprising part of the actuating system to which a manual action is applied

NOTE Adapted from IEV 441-15-22[24].

3.34
mechanical hazard
source of potential injury to a person created by motion of machinery, components or material

EXAMPLES Crushing and shearing points; trapping points; in-running nips; 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.

3.35
momentary-contact control
control that is opened or closed only during its actuation

3.36
motion control
control that initiates machine movement or movement at **zero speed** (3.64), or places the machine in the **armed condition** (3.2)

3.37
motion-control station
station that contains a **motion control** (3.36)

3.38
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) (3.29), or indirectly by other means

3.39
movable control station
control station that is permanently wired to the equipment, but which can be moved within a range limited by the length of the attached cable

3.40
movable guard
guard (3.21) that does not require a tool to move or remove it to gain access to a significant hazard

3.41
nip guard
guard (3.21) located at an in-going nip

EXAMPLES Nip bar, finger bar, finger guard.

3.42
normal operation
usual functioning and conditions that exist during set-up, make-ready, production and minor servicing, adjusting and cleaning performed by operators, but not including **maintenance** (3.31) operations

3.43
operating position
location where normal functions (make-ready and other routine, repetitive tasks) requiring control of the main drive motor(s) are performed

3.44
permissive period
time interval during which machine motion can be initiated

NOTE See 13.2.3.

3.45
personnel warning light
red or green light used to indicate the ready, running and safe conditions of the machine relative to personnel safety

NOTE These lights are not the same as machine **status lights** (3.57).

3.46
portable control station
control station that can be disconnected from one location, moved to another location and be reconnected

NOTE This is not the same as a **remote control** (3.51).

3.47
positive mechanical action
linkage of one component with another component such that movement of the former inevitably compels movement of the latter, either by direct contact or by a rigid connection

NOTE 1 This definition also applies to a component that prevents any movement of another component by virtue of its presence.

NOTE 2 When the movement of one mechanical component simply allows another component to move freely (e.g. by gravity, spring force, etc.), there is no positive mechanical action of the former component on the latter.

3.48
positive opening
contact separation as the direct result of a specified movement of the **actuator** (3.1) through non-resilient members, e.g. those not dependent on springs

3.49
raised workplace
area where functions are regularly performed, and are at least 0,5 m above access level

3.50
ready condition
status of a machine in which motion can be initiated by the operator

3.51
remote control
access connection to one or more control stations of a machine by use of an external communication link

NOTE This is not the same as **portable control station** (3.46).

3.52
routine and regular access
repetitive access to a hazard point that is required during normal production activity

3.53
safe condition
machine status in which movement of the main drive motor(s) (prime mover) of the motion zone is prevented, which may apply to the entire machine or to one or more motion zones, and which exists only when one or more stop/safe or emergency stop pushbutton(s) is/are latched in the depressed position

3.54
separating element
part on feeders of sheets, blanks or similar materials that separates the individual sheets, blanks, etc.

3.55
significant hazard
potential source of severe or disabling injury or death

3.56
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 2); or

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

NOTE "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 part of ISO 12643.

Dimensions in millimetres

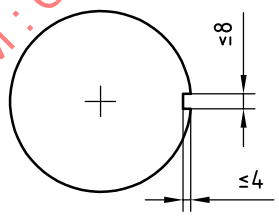


Figure 2 — Smooth roller/cylinder

3.57
status light
light that indicates machine status or machine process condition

NOTE Status lights are not the same as **personnel warning lights** (3.45).

3.58
tool
implement, such as a key or wrench, designed to operate a fastener

NOTE An item such as a coin or fingernail file is not considered to be a tool.

3.59
trip bar
protective bar that, when pushed, activates the interlocked safety system of the machine

3.60
trip nip bar
movable protective bar located at an in-running nip which, when pushed, activates the interlocked safety system of the machine

3.61
two-hand control
safety device that consists of two manual control devices that must be operated simultaneously by a single operator to initiate potentially hazardous machine motion

3.62
warning period
time interval during which machine motion is prevented and a warning is given to personnel that machine motion is about to occur

3.63
wireless control
transmission of commands and signals between a machine-control system and the motion-control station(s) using means other than a physical connection

3.64
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 **Zero speed** can be considered to be an **armed condition** (3.2).

4 Effective date

This part of ISO 12643 applies to new machines manufactured after December 31 of the year following the year of issue of this part of ISO 12643.

5 Guarding of significant hazards

5.1 General

Guarding, consistent with operation of the machine, shall be provided in those areas where it is recognized that operators are exposed to significant hazards. Exposure to significant hazards is not considered to exist if, during normal operation, the distance to the hazard complies with those specified in ISO 13852. Machinery shall be designed according to the principles of ISO 12100-1 and ISO 12100-2 for hazards that are relevant, but not significant, and which are not covered by this part of ISO 12643.

Significant hazards vary from machine to machine. It is important that each machine be evaluated to determine what hazards might exist and that shall be guarded.

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 devices shall provide protection against hazards. These operations shall be carried out using a hold-to-run device as specified in 5.4; 5.6; ISO 12643-2:2007, 5.3.2; or ISO 12643-2:2007, 5.7.4.2 (for folder delivery). 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.

EXAMPLES A transparent guard or remote viewing system.

5.2 Guards

5.2.1 Guard types and travel

5.2.1.1 Type of guards

For the purpose of this part of ISO 12643, there are two types of guards, fixed and movable.

Guards that do not have to be opened frequently shall be interlocked or shall be fixed in such a way that their removal necessitates the use of a tool (see 3.58), such as a key or wrench, designed to operate a fastener.

All movable guards shall be interlocked in accordance with 5.5.

Guards that are designed to be opened, removed, and/or moved at least once per working shift (on average) during normal operation, for make-ready (set-up) operations, or to permit access to a hazardous area, with or without the use of a tool, shall be interlocked.

NOTE 1 A typical working shift is 8 h.

Guards and doors may be removed for set-up and for other purposes.

NOTE 2 Examples include, but are not limited to:

— to supply the material to be processed;

— to change the format;

— to change tools;

— for make-ready.

The interlock system shall operate as described in 5.5.1.

When the interlocking guard is open, one of the measures set out in 5.6 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.

EXAMPLES 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.

5.2.1.2 Automatic travel of movable guards

Automatic travel of movable guards shall not create any significant mechanical hazards.

NOTE This can be achieved, for example, by limiting the force of the guard movement. The following guidelines are suggested:

a) 50 N or less where the likely contact surface of the guard 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 guard is a plane such that there is no risk of a crushing injury.

Higher values can be chosen based upon risk analysis.

5.2.1.3 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 may 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.

5.2.2 Guard positioning

5.2.2.1 Guard distances and gaps

The safety distance between the guard and the in-running nip is measured from that point where the distance between the rotating surfaces, or the rotating surface and a fixed surface, is 10 mm (see Figure 3). Safety distances shall be as specified in ISO 13852.

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 barrier guard.

The safety distance for guide rollers shall be a minimum of 120 mm.

Dimensions in millimetres

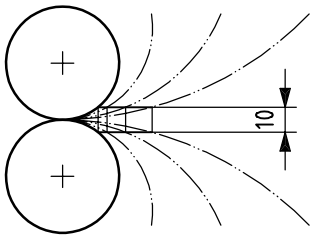


Figure 3 — Measuring safety distance at the in-running nips

5.2.2.2 Reaching upwards

If there is a low risk (as determined by risk assessment) from the hazard zone when reaching upward, then the height of the hazard zone shall be 2 500 mm or more, as specified by ISO 13852. Otherwise,

a) either the height of the hazard zone shall be 2 700 mm or more; or

b) other safety measures shall be used.

NOTE For further information on risk assessment, see ISO 14121[8].

5.2.2.3 Reaching over protective structures

If there is a low risk (as determined by risk assessment) from a hazard zone when reaching over a protective structure, the horizontal distance to the hazard zone as specified in Table 1 shall be used as minimum values. There shall be no interpolation of the values specified in that table. Therefore, when the known height of the hazard zone, a, the height of the protective structure, b, or the horizontal distance to the hazard zone, c, is between two values in Table 1, the value used shall be that which provides the higher level of safety.

Table 1 — Horizontal distance to hazard zone for low risk

Dimensions in millimetres

Height of hazard zone a	Height of protective structure b [a]								
	1 000	1 200	1 400	1 600	1 800	2 000	2 200	2 400	2 500
	Horizontal distance to hazard zone c								
2 500 [b]	—	—	—	—	—	—	—	—	—
2 400	100	100	100	100	100	100	100	100	—
2 200	600	600	500	500	400	350	250	—	—
2 000	1 100	900	700	600	500	350	—	—	—
1 800	1 100	1 000	900	900	600	—	—	—	—
1 600	1 300	1 000	900	900	500	—	—	—	—
1 400	1 300	1 000	900	800	100	—	—	—	—
1 200	1 400	1 000	900	500	—	—	—	—	—
1 000	1 400	1 000	900	300	—	—	—	—	—
800	1 300	900	600	—	—	—	—	—	—
600	1 200	500	—	—	—	—	—	—	—
400	1 200	300	—	—	—	—	—	—	—
200	1 100	200	—	—	—	—	—	—	—
0	1 100	200	—	—	—	—	—	—	—

[a] Protective structures less than 1 000 mm in height are not included because they do not sufficiently restrict movement of the body.

[b] For hazard zones above 2 500 mm, see 5.2.2.2.

If there is a high risk (as determined by risk assessment) from a hazard zone when reaching over a protective structure, the horizontal distance to the hazard zone as specified in Table 2 shall be used as minimum values. There shall be no interpolation of the values specified in Table 2. Therefore, when the known height of the hazard zone, a, the height of the protective structure, b, or horizontal distance to the hazard zone, c, is between two values in Table 2, the value used shall be that which provides the higher level of safety.

Table 2 — Horizontal distance to hazard zone for high risk

Dimensions in millimetres

Height of hazard zone *a*	Height of protective structure *b* [a]									
	1 000	1 200	1 400 [b]	1 600	1 800	2 000	2 200	2 400	2 500	2 700
	Horizontal distance to hazard zone *c*									
2 700 [c]	—	—	—	—	—	—	—	—	—	—
2 600	900	800	700	600	600	500	400	300	100	—
2 400	1 100	1 000	900	800	700	600	400	300	100	—
2 200	1 300	1 000	1 000	900	800	600	400	300	—	—
2 000	1 400	1 300	1 100	900	800	600	400	—	—	—
1 800	1 500	1 400	1 100	900	800	600	—	—	—	—
1 600	1 500	1 400	1 100	900	800	500	—	—	—	—
1 400	1 400	1 400	1 100	900	800	—	—	—	—	—
1 200	1 500	1 400	1 100	900	700	—	—	—	—	—
1 000	1 500	1 400	1 000	800	—	—	—	—	—	—
800	1 500	1 300	900	600	—	—	—	—	—	—
600	1 400	1 300	800	—	—	—	—	—	—	—
400	1 400	1 200	400	—	—	—	—	—	—	—
200	1 200	900	—	—	—	—	—	—	—	—
0	1 100	500	—	—	—	—	—	—	—	—

a Protective structures less than 1 000 mm in height are not included because they do not sufficiently restrict movement of the body.

b Protective structures lower than 1 400 mm should not be used without additional safety measures.

c For hazard zones above 2 700 mm, refer to 5.2.2.

5.2.3 Guard openings

Guard openings shall comply with the requirements of ISO 13852. For guarding in-running nips that are accessible while a movable guard is open, see 5.3.

5.3 In-running (in-going) nips

Hazards from in-running nips may exist between the following:

— two counter-rotating surfaces, powered or non-powered (see Note);

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

— surfaces rotating in the same direction, but with different peripheral speeds or surface properties, such as friction;

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

— non-powered riding rollers (guide rollers) that are driven by the movement of the product.

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

Examples of in-running nips are shown in Figure 1.

5.4 Guarding in-running nips

5.4.1 General

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 3;

b) nip guard (only allowed on smooth rollers/cylinders), as bars designed in suitable sections and extending across the entire working width (see Figure 4 for examples of nip guards);

c) trip nip bars shall be in accordance with 9.6.

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.

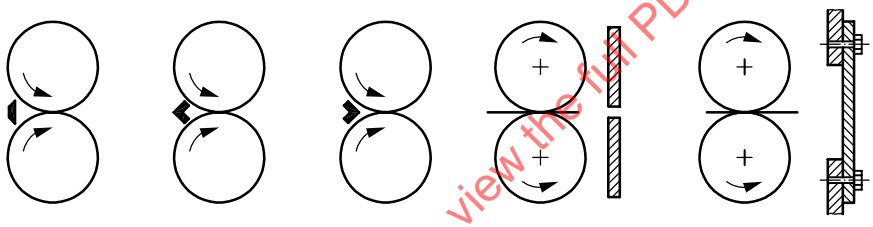
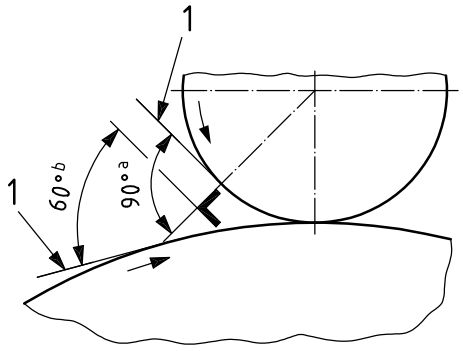


Figure 4 — Examples of nip guards

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 5).



Key

1 tangent

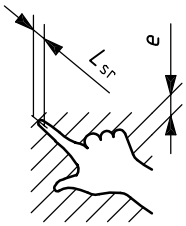
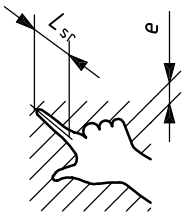
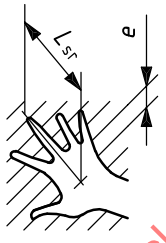
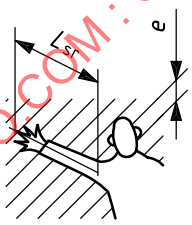
[a] Preferred.

[b] Acceptable.

Figure 5 — Minimum cylinder-to-guard angle

Table 3 — 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		$e \leqslant 4$	$\geqslant 2$	$\geqslant 2$	$\geqslant 2$
		$4 < e \leqslant 6$	$\geqslant 10$	$\geqslant 5$	$\geqslant 5$
Finger up to knuckle joint or hand		$6 < e \leqslant 8$	$\geqslant 20$	$\geqslant 15$	$\geqslant 5$
		$8 < e \leqslant 10$	$\geqslant 80$	$\geqslant 25$	$\geqslant 20$
		$10 < e \leqslant 12$	$\geqslant 100$	$\geqslant 80$	$\geqslant 80$
		$12 < e \leqslant 20$	$\geqslant 120$	$\geqslant 120$	$\geqslant 120$
		$20 < e \leqslant 30$	$\geqslant 850$ [a]	$\geqslant 120$	$\geqslant 120$
Arm up to junction with shoulder		$30 < e \leqslant 40$	$\geqslant 850$	$\geqslant 200$	$\geqslant 120$
		$40 < e \leqslant 120$	$\geqslant 850$	$\geqslant 850$	$\geqslant 850$

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 $\leqslant 65$ mm, the thumb will act as a stop and the safety distance can 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 6). On small-format machines, the clearance should be smaller, if possible, considering both safety and production concerns.

Nip guards shall not be shaped or oriented such that a “wedge pocket” is created (see Figure 7 and Figure 8). The shapes shown in Figure 7 may be used as trip nip bars, since activation of the trip nip bar stops hazardous motion, as specified in 5.7.4.

Dimensions in millimetres

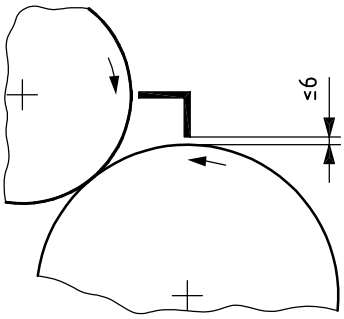
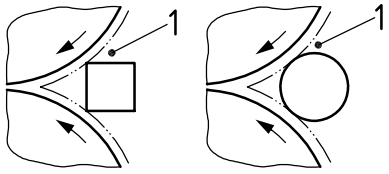


Figure 6 — Safeguarding an in-running nip by means of a fixed nip guard



Key

1 wedge pocket

Figure 7 — Shapes creating wedge pockets

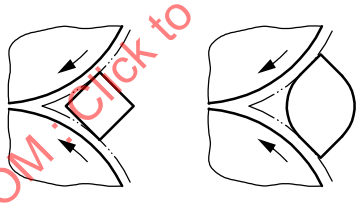


Figure 8 — Shapes not creating wedge pockets

5.5 Interlocks

5.5.1 Opening an interlocking guard

When an interlocking guard is opened, moved or removed while the machine is in continuous motion, the machine shall stop, utilizing the maximum braking action established for that machine. When any interlocking guard is open, initiation of continuous run shall not be permitted. Closing or replacing 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.

EXCEPTION — If a machine is operating at inching speed and under the conditions defined in 5.6, motion may continue.

5.5.2 More than one interlocking guard open

Where more than one interlocking guard is open and there are any unguarded hazard zones that cannot be observed from a single point of operation, only an inch function or reverse inch function (as specified in 9.2.3.5) 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.

5.5.3 Remote control with interlocking guard open

When any interlocking guard is open, initiation of motion of the system by remote control shall be prohibited (see 11.1).

5.5.4 Interlock design

5.5.4.1 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 14119:1998, Clauses 5 and 6, shall be satisfied.

5.5.4.2 Personnel safety switches for interlocking guards

For personnel-safety switches built in accordance with IEC 60947-5-1 and installed in accordance with IEC 60204-1, it may be assumed that no malfunctions will occur.

For machines where routine and regular access to a hazardous area is not required, it is therefore sufficient to provide only one personnel safety switch for each interlocking guard.

Control systems of safety-position switches shall satisfy Category 3 of ISO 13849-1:1999.

For manually fed devices where interlocking guards are used to safeguard routine and regular access (see 3.52) to hazard points, control systems for safety-position switches shall satisfy Category 4 of ISO 13849-1:1999.

5.5.4.3 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 5.5.4.2 and 11.1.1 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.

5.5.5 Interlocking with guard locking

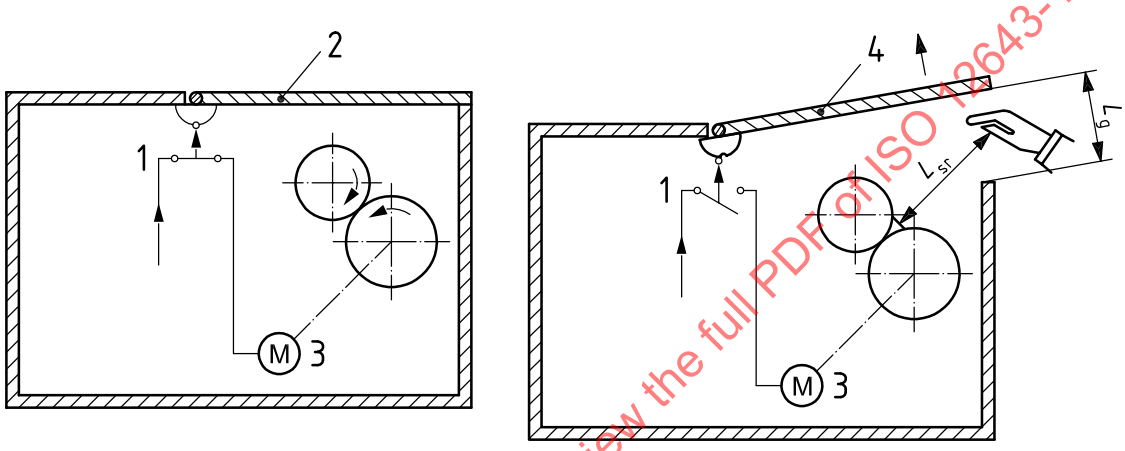
Interlocking guards shall be designed so that the sensor (interlock) shall be activated within the limits specified in Table 4, depending on the distance to the hazard. Otherwise, guard locking shall be utilized.

NOTE EN 1010-2 and EN 1010-4 also require guard locking where hazardous movement cannot be stopped within at least 10 s after actuation of the personnel safety switch.

Table 4 — Requirements for interlocking guards without guard locking

Safety distance [a], L_{sr}, between guard opening and hazard point mm	Maximum opening [a], L_g, of the guard while the detector changes its state mm
< 80	$\leqslant 30$
$\geqslant 80$ and < 500	$\leqslant 40$
$\geqslant 500$ and < 850	$\leqslant 80$
$\geqslant 850$	$\leqslant 160$

[a] See Figure 9 for location of the measurements.



a) Motor running

b) Motor stopped

Key

1 failsafe limit switch
2 guard closed
3 motor
4 guard open

L_{sr} safety distance
L_g maximum opening

Figure 9 — Distances related to requirements for guard locking

5.6 Hold-to-run controls

If all hazard points are safeguarded by nip guards in accordance with 5.4, the requirements for hold-to-run controls and speed limitations do not apply.

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 hazardous areas that are not visible from the operating position are closed.

When the hazardous area 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 only 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 hazard.

Guard circuitry for the hold-to-run condition shall satisfy the requirements of Category 3 of ISO 13849-1:1999. Control circuitry (including selector switch relays and PLC circuits) that allows interlocked areas to be operated independently shall satisfy the requirements of Category 1 of ISO 13849-1:1999.

For hold-to-run devices designed as two-hand controls, the same limitations of displacement and speed shall apply.

At speeds faster than 5 m/min, the maximum speed shall be as low as possible and no faster than 10 m/min, provided either a two-hand control is used, or the control is located such that the hazard cannot be reached from the operating position and the operator has clear view of the hazard.

NOTE EN 1010-1 permits motion at speeds between 5 m/min and 10 m/min only with the use of a two-hand control.

For machine-specific exceptions to this speed requirement, see ISO 12643-3:—, 6.2.3, 6.2.6 and 6.2.7.

For machines included in Clause 4 and not having a specific exception in ISO 12643-3, any speed greater than 10 m/min shall have a means of achieving a level of safety equivalent to that at 10 m/min.

EXCEPTION — Where machine-specific requirements allow for speeds greater than 10 m/min, all of the following requirements shall be met.

— Other interlocking guards in an area that cannot be observed by the operator from the operating position shall be closed.

— A selector switch for this kind of operation shall be provided in addition to a two-hand control.

— The hold-to-run speed shall be the slowest possible under procedural requirements.

Any two-hand control device shall meet the requirements specified in 9.5. The stopping path shall be as short as technically feasible.

See 11.1 for general requirements for control systems.

5.7 Other safeguarding measures

5.7.1 General

Where safeguarded accessible hazard zones cannot be observed from positions from which hazardous movements can be started, the requirements of 5.7.2 to 5.7.4 shall apply.

5.7.2 Fence-type enclosures

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

a) it shall not be possible for (a) person(s) 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.

EXAMPLES 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 13852.

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

It shall not be possible to initiate machine motion while a person is within the hazard zone except under hold-to-run conditions as defined in 5.6.

5.7.3 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 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 comply with 9.6.

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

Pressure-sensitive mats, pressure-sensitive bumpers and trip nip bars shall function in accordance with 9.7.

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 shall be used as a basis for determining the correct positioning of the pressure-sensitive mats.

5.7.5 Auxiliary devices that act as guards

Auxiliary devices 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 hazardous areas, 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 5.5).

NOTE 1 Auxiliary devices are defined in 3.5.

NOTE 2 For example, auxiliary devices that prevent access to hazard points in their built-in position can 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, exposing a hazard, alternative guards shall be used to protect the hazard point(s).

5.8 Guarding reel unwinding, rewinding and transport devices

5.8.1 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), any accessible hazard point between the reel and the belt shall be safeguarded if the force between belt and reel is more than 300 N. Guards shall be provided for protecting the in-running nips on the drive belt guide rollers (see Figure 11).

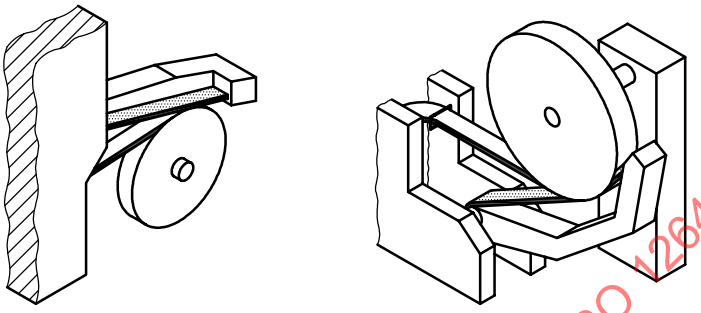


Figure 10 — Belt drives

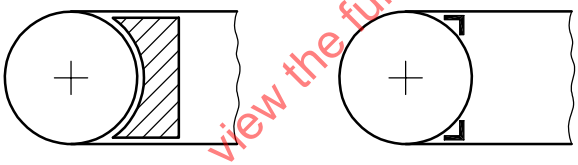


Figure 11 — Safeguarding of belt in-running nips on belt drives

5.8.2 In-running nips

On unwinding and rewinding devices, the accessible in-running nips at reels, pressure rollers or support rollers shall be safeguarded by means of guards or safety devices having approach reaction (trip nip bars, pressure-sensitive mats, electro-sensitive devices). The safety device selected shall be effective at all operating reel diameters and operating speeds. Access to the in-running nip from the side shall not be possible.

Included in this requirement is the safeguarding of the in-running nip facing the machine, if drawing-in hazards exist as long as the diameter of the reel is small (at the beginning of the rewinding process) or the diameter of the pressure roller is small.

For trip nip bars and pressure-sensitive mats, see 5.7.4 and 9.7. For electro-sensitive protective devices, see 5.7.3 and 9.6.

5.8.3 Chucking cones on devices using non-automatic control

On unwinding or rewinding devices using non-automatic control, the chucking cones shall be designed so that they can be inserted only while the device moving the cones is 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 shall be as specified in 5.6.

For automatic reel loading, see 5.8.10.

5.8.4 Separation of chucking cones

Provision shall be made to prevent unintentional separation of the chucking cones after the reel has been lifted.

NOTE 1 For example, unintended separation can be prevented by allowing the chucking cones to separate only in the hold-to-run control mode at a maximum speed of 2 m/min, or by two-hand control.

Separation of the chucking cones during the unwinding or rewinding motion shall be prevented.

NOTE 2 For example, an interlocking system can be used to prevent separation of the chucking cones during roll movement.

5.8.5 Non-conical chucking devices

Where there is a risk of damaging non-conical chucking devices by lifting only one end of the roll, provisions shall be made to prevent lifting only one end of the roll more than 50 mm.

NOTE 1 Risk of damaging non-conical chucking devices by lifting only one end of the roll exists, for example, when a heavy, long roll is stuck on the chucking device.

NOTE 2 These provisions are to help prevent possible damage to the chucking device, which could possibly result in the unexpected release of the roll. Generally, this risk increases in proportion to the width and mass of the roll.

5.8.6 Shaftless unwinding and rewinding units

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

NOTE 1 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.

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

NOTE 2 This prevention can be done, for example, by

— 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.

5.8.7 Lifting arm

If hazard points between lifting arm(s) and machine frame cannot be avoided by built-in design or be safeguarded, the lifting arm(s) shall be movable only in the hold-to-run control mode. Control devices shall be arranged such that hazard points can be observed from the place of actuation. The hold-to-run speed shall be as specified in 5.6.

5.8.8 Protection against drawing in hazard

On reel unwinding and rewinding devices, provisions shall be made to guard against being drawn in between the end surface of a rotating paper reel and fixed parts or lifting arms if the distance is less than 25 mm.

5.8.9 Transport of the material reel to the reel stand

On semi-automatic reel transport systems, transport of the material reel to the reel stand shall be done in the hold-to-run control mode with a maximum speed of 20 m/min. The stopping path shall not exceed 200 mm. It

shall be possible to clearly see the total transport way from the respective hold-to-run control position. Safety distances to prevent crushing parts of the human body shall comply with ISO 13854.

5.8.10 Protection of hazard zones on unwinding unit of automatic reel-loading systems

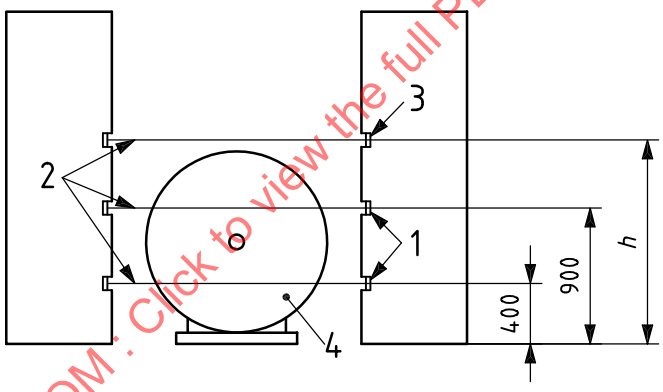
On automatic reel-loading systems, the hazard zone associated on the unwinding unit shall be completely safeguarded by electro-sensitive devices or by guards. Hazard zones exist between material reel and fixed machine parts, between the material reel and the lifting arm and the floor, and between material reel and the chucking cone.

Where ESPDs, in accordance with 5.7.3, are used for safeguarding the automatic reel-loading area on unwinding units, the device may be muted while material reels or unwound cores are transported through the area safeguarded by the electro-sensitive device under the following conditions:

— An additional photoelectric device is provided at a height (h) of not more than 50 mm above the top of the largest reel that will cause immediate stopping of all hazardous movements on the unwinding unit whenever the beam is interrupted during insertion of the material reel or removal of unwound cores, caused by persons accessing the hazard area or other intrusions (see Figure 12).

— Emergency stop devices shall be provided within easy reach on the unwinding unit that will also stop the automatic loading operation.

Dimensions in millimetres



Key

1 photoelectric device
2 photoelectric beams
3 additional photoelectric device
4 reel
h height to the top of the largest reel plus a maximum of 50 mm

Figure 12 — Use of ESPDs to guard automatic reel loading on unwinding unit on automatic reel loading systems

5.9 Threading of web material

On machines, safe threading of the web-type material shall be ensured. For certain types of machines, this may 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 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 may 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.

5.10 Feeding units, delivery units (pile lifting and lowering devices)

5.10.1 Pile lifting and lowering devices

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

NOTE 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.

5.10.2 Breaking strength of components

On lifting and lowering devices with production format sizes greater 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 less than 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.

5.10.3 Lifting height of pile lifting and lowering devices

5.10.3.1 Pile carrier

On pile lifting and lowering devices with production format sizes greater 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.

NOTE This requirement is satisfied for worm 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.

EXCEPTION — This requirement does not apply to gears that are rated for double load. This requirement also does not apply 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. See also 5.10.4.1.

5.10.3.2 Pile carrier plate

On pile lifting and lowering devices with production format sizes greater than 2,5 m^2, the area below the pile carrier plate shall be safeguarded by guards or by electro-sensitive protective devices. ISO 13855 need not be considered.

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

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 plate 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 of greater than 1,0 m^2, and on deliveries with format production sizes of greater 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 plates.

   1) Resilient, non-switching, overhanging shields with their forward edges protruding over the hazardous edges by at least 250 mm shall be used (see Figure 13).

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

   3) A horizontal distance of 300 mm between the vertical projection of the machine frame and the pile carrier plate shall be used. 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 14). To lower the pile carrier plate below 120 mm, hold-to-run control shall be used.

   4) Pressure-sensitive bumpers or trip devices shall be used.

   5) Hold-to-run control shall be used on feeders 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 greater than 2,5 m^2, the hazard point shall be safeguarded by one or more of the following safety devices:

   1) guard;

   2) photoelectric device in front of the edge of the pile carrier plate, or on board feeding and delivery units by a photoelectric device fitted at a distance of 300 mm minimum from the edge of the pile carrier plate;

   3) other presence sensing devices as defined in 5.7.3 and 5.7.4.

Where platforms or gangways are fitted to the feeding or delivery unit, the hazard point between platform or gangway and the edge of the pile carrier plate shall be safeguarded. See also 5.10.4.1.

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

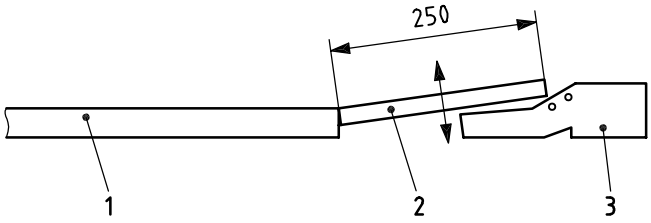
— minimum distance of 120 mm between pile carrier edge and edge of platform;

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

— 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 device.

Dimensions in millimetres



Key

1 pile carrier plate
2 overhanging shield
3 foot

Figure 13 — Overhanging shield

Dimensions in millimetres

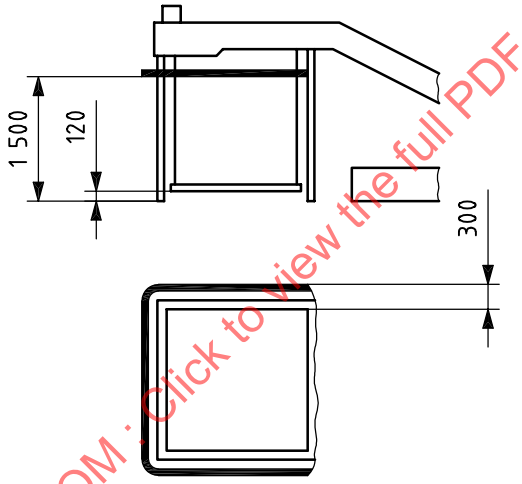


Figure 14 — Safeguarding by deflecting parts of the machine frame

5.10.4 Guarding crushing and shearing points

5.10.4.1 Guarding sheet feeding and delivery units

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

NOTE For example, safeguarding may be done by one of the following measures:

— safety distances in accordance with ISO 13854;

— trip devices;

— guards;

— hold-to-run operation.

On the delivery of sheet-fed printing presses and coating units with a pile carrier, where a pile mass of 500 kg is not exceeded and safeguarding in accordance with 5.10.3.2 is not practical for operational reasons, crushing of the toes shall be prevented as defined in ISO 13854 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 printing press or under hold-to-run control. Pile carrier wheels shall be fitted as far to the centre of the carrier plate as possible without decreasing stability.

5.10.4.2 Pile changing devices for sheet-feeding and delivery systems

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, safeguarding shall be provided. This can be achieved by means that include, but are not limited to:

— fixed or interlocking guards in accordance with 5.2;

— electro-sensitive protective devices in accordance with 5.7.3;

— safety distances and gaps in accordance with ISO 13852 and ISO 13854;

— hold-to-run control in accordance with 5.6;

— trip devices in accordance with 9.7.

For trip devices the requirements of Category 3 of ISO 13849-1:1999 shall be satisfied.

5.10.5 Separating elements on feeders

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

Where blanks are fed from the top of the pile, the requirement is satisfied if safety distances between suction heads are used or if suction heads touch down only under spring force.

5.10.6 Suction heads on sheet feeders

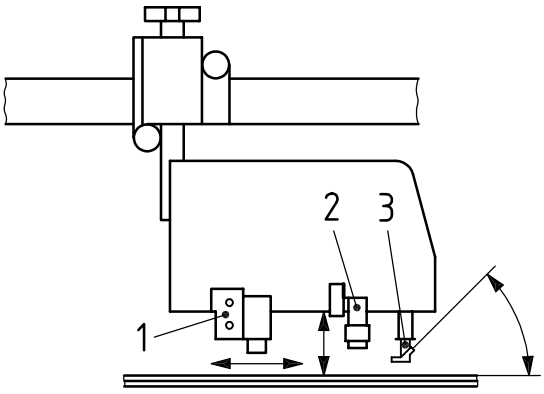
Hazard points on suction head drive gears that can be accessed during the production process shall be safeguarded by guards completely enclosing the head, leaving only the bottom open (see Figure 15). Hazard points caused by moving parts outside the suction head (such as a forwarding sucker or lifting 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) any hazard points (shearing and crushing hazards) are protected by guards.

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



Key

1 forwarding sucker

2 lifting suckers

3 pressure foot

Figure 15 — Movement of the suction head

5.10.7 Pull-in and forwarding wheels

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

NOTE For example, this can be achieved by one or more of the following:

— using a deflection of 25 mm (obtained with a force that would not cause injury);

— using a deflection of 15 mm (obtained with a force that would not cause injury) with roller widths limited to 25 mm;

— providing guards in accordance with Clause 5.

6 Requirements for protection against other hazards

6.1 General

Protection shall be provided against other hazards as defined in 6.2 to 6.16.

See ISO 12643-2:2007, Annex A, and ISO 12643-3 for a list of hazards.

6.2 Fire and explosion

6.2.1 General

Explosion zones shall be identified through risk assessment for the applicable equipment. For a list of explosion zones identified for press systems, see ISO 12643-2:2007, Annex B. For a list of explosion zones identified for roller coating systems, see ISO 12643-3.

6.2.2 Fans

Fans integrated in machines to exhaust potentially explosive atmospheres (fumes, dust, etc.) shall be designed such that they do not introduce an ignition hazard, and shall be built in compliance with requirements defined for individual explosion zones.

6.2.3 Hoses and pipes

Hoses and pipes used for combustible or explosive materials, or for impregnating material, shall be conductive and electrostatically grounded (resistance less than 10^6 Ω over the total length of the hose).

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

Hoses and pipes used for exhausting solvent vapours shall be conductive and electrostatically grounded (resistance less than 10^6 Ω over the total length of the hose) where the solvent concentration under any single failure may exceed 25 % of the lower explosion limit (LEL).

Measurement of resistance shall be made in accordance with ISO 8031.

6.2.4 Electric motors for pumps

The electric motor for pumps on supply ducts for inks, coating substances, impregnating material or glues shall be protected as specified in IEC 60079-1. Where protective motor switches are mounted on the pump, compliance with IEC 60079-7 is considered to be sufficient.

Solvents, including those evaporating from the agitator shaft, shall be prevented from reaching the motor. The distance between the electric drive motor for viscosity control and the outer flange of the agitating device shall be at least 50 mm.

NOTE One means of preventing solvents evaporating from the agitator shaft from reaching the motor is to mount a disc on the shaft.

6.2.5 Prevention of ignition of explosive atmospheres by electrical apparatus

If the build-up of explosive atmospheres under normal operating conditions or under operational disturbances cannot be avoided, especially by means of ventilation, additional measures, dependent on the zones defined in ISO 12643-2:2007, Annex B and ISO 12643-3:—, Annex B, shall be taken in order to avoid ignition of the explosive atmosphere.

— Electrical apparatus shall comply with IEC 60079-14.

— For electrical apparatus used in Zone 0, IEC 60079-11 shall also apply. Electrical apparatus used in Zone 1 shall additionally comply with one or more of the following standards for explosion protection: IEC 60079-1, IEC 60079-2, IEC 60079-5, IEC 60079-6, IEC 60079-7, IEC 60079-11 and IEC 60079-18.

— Electrical apparatus designed in accordance with IEC 60079-11 shall be designed to explosion group IIA. (For a description of the electrical apparatus that are considered to be group II, see IEC 60079-0[15].)

— Depending on the type of solvent used, the chosen temperature class shall ensure that the electrical apparatus cannot be a source of ignition due to its surface temperature. (For a description of surface temperature classifications for electrical apparatus, see IEC 60079-0[15].)

— Brakes and clutches shall be designed such that they cannot be a source of ignition.

— Hazardous electrostatic charges shall be minimized, as far as technically feasible (e.g. by using static eliminators).

6.2.6 Explosion protection exceptions

Explosion protection is not required for machinery where there are no combustible liquids with a flash point below 55 °C being used and no combustible liquids are sprayed or heated to a temperature above flash point under operating conditions. All other machinery shall satisfy the requirements of EN 1127-1 as well as the requirements of 6.2.4 and ISO 12643-2:2007, 6.2.2.

NOTE 1 For washing equipment, see ISO 12643-2:2007, 6.7 and 11.9.

NOTE 2 Heating of a combustible liquid occurs under operational conditions; for example, in film and printing plate development units with bath heating.

The requirements of EN 1127-1 are satisfied where the build-up of explosive atmospheres is prevented by adequate ventilation systems. This applies where the level of 25 % of the lower explosion limit is not exceeded even if the system fails.

EXAMPLE An example of system failure would be a breakdown of the ventilation system.

6.3 Electrical equipment

6.3.1 General

All electrical equipment shall be designed in accordance with IEC 60204-1, such that electrical hazards (such as electric shock or burns) are prevented. The requirements of IEC 60204-1 shall be fulfilled, taking into account the additional requirements specified in 6.3.2 to 6.3.6.

6.3.2 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, utilization Category AC-23B or Category DC-23B; or a circuit-breaker suitable for isolation in accordance with IEC 60947-2.

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

If actuation of a stopping device will cause 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 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.

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, the electrical equipment shall have a device for switching the machine on and off.

6.3.3 Installation

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

6.3.4 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

— it is identified by colour in accordance with IEC 60204-1; 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.

6.3.5 Testing of electrical equipment

All electrical equipment shall be designed such that it will withstand the testing specified in IEC 60204-1. Voltage tests as specified in IEC 60204-1 are not required for electronic control circuits.

6.3.6 Measuring devices

Measuring devices shall comply with IEC 61010-1.

6.4 Working platforms, access stairs, passageways and raised workplaces

6.4.1 General requirements

For regular operation, the means of access and passageways to workplaces shall comply with the requirements of ISO 14122-1, ISO 14122-2 and ISO 14122-3. For infrequently used workplaces (see 3.26), the exceptions specified in 6.4.2 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.

The reader should be aware of the effects of mathematical conversion and rounding when converting from SI units to other units.

NOTE For example, requirements stated by the U.S. Occupational Health and Safety Administration (OSHA) may supersede the resulting conversions in the U.S.

6.4.2 Exceptions for infrequently used platforms and access steps

6.4.2.1 General

As an exception to the requirements of 6.4.1, infrequently used platforms and access steps shall comply with the requirements of 6.4.2.2 to 6.4.2.6 below.

6.4.2.2 Ergonomics

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

EXAMPLES 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.

6.4.2.3 Footstep dimensions

6.4.2.3.1 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.

6.4.2.3.2 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.

6.4.2.3.3 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.

6.4.2.4 Handle dimensions

Where handles are required, the following dimensions shall apply (see Figure 16):

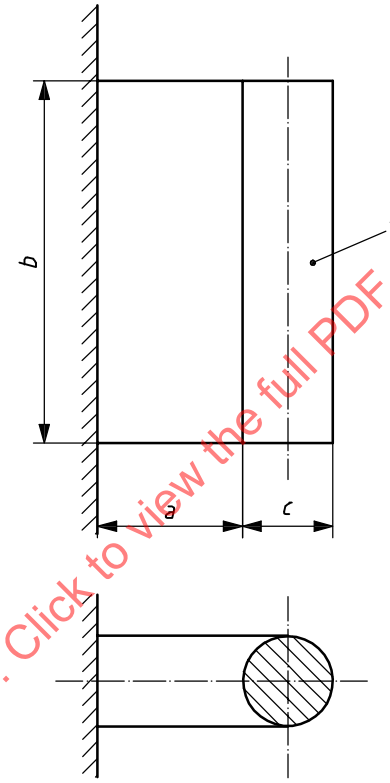
— minimum handle clearance 40 mm;

— minimum handle length 110 mm;

— minimum handle diameter 20 mm;

— maximum handle diameter 50 mm.

Dimensions in millimetres



Key

1 handle

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

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

c handle diameter (20 mm $\leqslant c \leqslant$ 50 mm)

Figure 16 — Handles for infrequently used access platforms

6.4.2.5 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 6.4.1 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.

6.4.2.6 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 17). 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

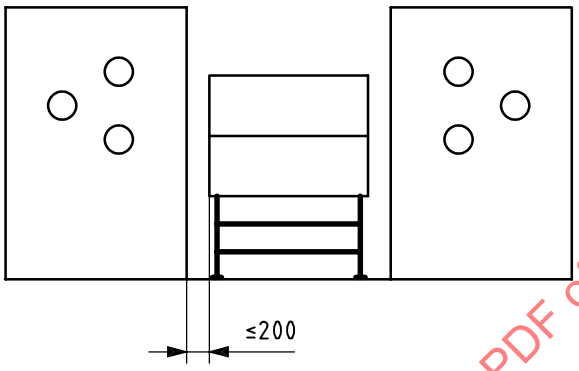


Figure 17 — Mobile platform

6.4.3 Platform, gangway, and step surfaces

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

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, 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.

6.4.4 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°.

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

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.

The reader should be aware of the effects of mathematical conversion and rounding when converting from SI units to U.S./Imperial units.

NOTE Requirements stated by the U.S. Occupational Health and Safety Administration (OSHA) may supersede the resulting conversions in the U.S.

6.4.5 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).

6.4.6 Infrequently used workplaces

For infrequently used workplaces (see 3.26) 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.

6.4.7 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.

EXCEPTION — The toe plate is not required up to a falling height of 1,6 m; however, intermediate rails shall be fitted in the middle between handrails and floor.

6.5 Stability

6.5.1 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

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 may include, but are not limited to,

— 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.

6.5.2 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.

Where possible, automatic locking devices should be fitted.

Unintended travel on wheels and caster wheels with no brakes may 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).

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

6.6 High contact temperatures

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

NOTE 1 Means to safeguard against contact with heated parts include the use of insulation, guarding or by distance.

NOTE 2 See ISO 12643-2:2007, 9.6.5, for safeguarding of heated parts of continuous-flow drying devices.

6.7 Noise

Machines shall be so designed and constructed that risks from noise emission produced by the machines are reduced to the lowest practical level for that type of machine. Means to reduce noise include sound absorption materials, covers, silencers, vibration dampening or selection of component materials or other methods as specified in ISO/TR 11688-1.

Sound measurements to determine the noise emission shall be carried out in accordance with the requirements specified in EN 13023 and ISO 11689.

NOTE 1 Examples of significant sources of noise include 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 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 should be consulted.

NOTE 3 See Annex B for guideline values from the German Berufsgenossenschaft (BG), and test results from Japan.

6.8 Radiation hazards

6.8.1 Laser devices incorporated in machinery

Laser devices incorporated in machinery shall comply with the requirements of ISO 11553-1 and IEC 60825-1. 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 limit values as specified by IEC 60825-1 for the intended use of the machine.

During repairs, it may 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.

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 Clause 15.

6.8.2 Ultraviolet irradiance

The level of ultraviolet irradiance emitted by machinery shall not exceed Category 1 limit values as specified in EN 12198-1:2000, Table B.1, for permanent workplaces, as well as for occasionally occupied positions. Actual irradiance values shall be determined as specified in EN 12198-1:2000, Annex B.1 and Table B.2.

The values specified for Category 1 of EN 12198-1:2000, Annex B.1, Table B.2, refer to the maximum duration of exposure of 8 h per day. Where the location of measurement points or normal conditions of operation allow the expected time, t_{exp}, in hours, of exposure per person to be less than the maximum duration, the UV-B/C radiation limit value of 1×10^{-3} W/m^2 may be multiplied by the factor $8/t_{exp}$. The UV-A radiation limit value is 10 W/m^2 for exposure times from 1 000 s to 8 h. If the exposure time is less than 1 000 s, the limit value for radiation emission is calculated by dividing the radiation value of 10 000 J/m^2 by the exposure time defined in seconds.

A lower maximum duration of exposure may 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).

6.8.3 Ozone hazards caused by UV radiation

Every attempt shall be made at the design state 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.

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, for 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 satisfy Category 1 of ISO 13849-1:1999.

6.9 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.

6.10 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 Clause 5 shall be satisfied.

NOTE 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.

6.11 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”.

6.12 Protruding machine parts

Machine parts that unavoidably protrude, causing a collision hazard, shall be padded and provided with a distinctive and permanent marking.

6.13 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.

6.14 Routine handling of heavy machine parts

Where heavy machine parts need to be removed and replaced regularly, necessitating the lifting of a load of at least 25 kg per person, the need for the user to provide adequate means of lifting and transport shall be indicated in the instruction handbook (see 15.4).

NOTE 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.

The 25 kg requirement shall apply when ideal lifting conditions exist. Under conditions that are less than ideal, e.g. where lifting is more difficult such as from positions that require unfavourable body postures, the use of lifting devices may be required for lifting loads less than 25 kg.

Determination of the lifting condition should take into consideration such things as distance between the body and the load, how high the load must be lifted, the shape of the object being lifted, the need to twist the body while lifting, etc.

The reader should be aware of the effects of mathematical conversion and rounding when converting from SI units to U.S./Imperial units.

NOTE Requirements stated by the U.S. Occupational Health and Safety Administration (OSHA) may supersede the resulting conversions in the U.S.

6.15 Oxidizers, incinerators or thermal cleaning plants

Hazards associated with oxidizers, incinerators and thermal cleaning plants shall be reduced or, where possible, prevented.

NOTE For guidance, see EN 12753[41], NFPA 86[50] and EN 746-1[31].

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

6.16 Protection against crushing and shearing hazards

6.16.1 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 13852 and ISO 13854. Risk of crushing exists between movable parts such as lifting arms, paper reel and devices for acceleration, cutting and gluing, or in connection with fixed parts such as side frames, connecting bars or floor.

6.16.2 Control and measuring devices

Crushing and shearing points between movable and fixed parts of control and measuring devices on systems shall be safeguarded.

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

— safety distances in accordance with ISO 13854;

— limiting the operating force to a non-hazardous level;

— electro-sensitive protective devices in accordance with 9.6;

— guards in accordance with 5.2.

6.16.3 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.

The following are examples of safeguarding:

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 9.6.1 and 9.6.3. Hand approach speeds according to ISO 13855 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, an 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 stand a static load of 1,25 times the maximum load capacity without permanent deformations or apparent defects. It shall be able to stand 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 button shall be provided on each motion-control station.

7 Release from hazardous situation

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

NOTE Release mechanisms can include

— 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.

8 Control zones

8.1 General

A system can consist of a multitude of machines and control systems. These may 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 may be used for independent operation. In other cases, these control zones may be combined to form a larger control zone.

8.2 Purpose of zone configuration

Generally, the purpose of zone configuration is to avoid the situation where pushing an emergency stop in one zone stops motion in all zones. However, it is possible to configure the system such that an emergency stop control would affect all motion zones of the system (see 9.2.3.1.2).

Each control zone shall have a safety signalling system as specified in Clause 14, if the overall view of the personnel by the operator is obstructed or communication between operating personnel is difficult within that control zone. Each control zone shall also have a motion-control station as described in Clause 10.

See ISO 12643-2:2007, Clause 9, for an exception for web presses with multiple folders.

8.3 Motion-control stations in control zones

The motion-control stations within each control zone shall affect the hazardous motion of all equipment within that control zone. When multiple control zones are combined into a larger control zone, all motion-control stations within the larger control zone shall be able to control all hazardous motion in that zone.

EXCEPTION — Some auxiliary equipment, although part of the system, does not affect motion of other portions of the system. The function or motion of this auxiliary equipment is affected only by its own motion-control station(s) and/or the motion of specific other equipment within the system. Motion-control stations on this auxiliary equipment shall not cause motion of any other machine within the system.

NOTE Examples of such auxiliary equipment include splicers, stackers/palletizers, stream feeders, hopper loaders, ink jet devices, labelling machines, card blowers, etc.

Any motion-control station that can initiate motion shall also have a stop function to stop that same motion.

Portable motion-control stations shall function in accordance with 10.1.2. Wireless motion-control stations shall function in accordance with 10.2.2.

If some portion of the control zone is not currently being used, the stop/safe and guard interlock functions of that unused portion shall not be disabled.

EXCEPTION — Guard interlocks on the unused portion of the control zone may be disabled only if

— the unused portion of the machine is disengaged (declutched, de-energized, etc.), or all energy sources are locked, blocked or otherwise effectively controlled,

— after opening the guard, the hazardous area of another zone cannot be reached.

If the motion-control station for the unused portion of the control zone can initiate motion, the stop/safe function shall not be disabled.

If portions of the system are being used independently, thus creating separate control zones, the motion-control stations for each control zone shall be independent of any other.

For example, for a system that contains a gatherer, binder, trimmer, conveyor and polywrapper, the trimmer, conveyor and polywrapper may be temporarily used together as a small independent system. This will create two independent control zones, one consisting of the trimmer, conveyor and polywrapper (control zone A), the other consisting of the gatherer and binder (control zone B). In this case,

— the motion-control station of each machine within control zone A affects motion of all machines within control zone A,

— the motion-control station of each machine within control zone B affects motion of all machines within control zone B,

— the motion-control station of each machine within control zone A does not affect motion of any machine within control zone B and vice versa.

9 Controls

9.1 General

This clause addresses specific controls that shall meet the criteria put forth in this part of ISO 12643. The system may have other controls not specified in this part of ISO 12643, 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.

9.2 Manual control devices

The requirements in this subclause apply only to the system drives that cause hazardous motion.

Unless otherwise specified by this part of ISO 12643, the manual control devices specified by this part of ISO 12643 shall be flush.

EXCEPTION — The manual control devices on touchpads may be slightly raised or slightly recessed to enhance tactile recognition.

Operating elements of manual control devices for starting hazardous movements shall be safeguarded against unintended actuation.

Manual control devices shall be designed and located so that

— 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 operation cannot cause additional risk.

Where a control device is designed and constructed to perform several different actions, the action to be performed shall be clearly displayed and subject to confirmation where necessary.

Control devices shall be so arranged that their layout, travel and resistance to operation are compatible with the action to be performed, taking into account ergonomic principles. 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 the start/stop function is performed by means of a hold-to-run control device, a separate stop control 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, 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 controlled elements when actuating them.

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.

For emergency stopping devices, the requirements of ISO 13850 and IEC 60204-1 shall be satisfied.

If symbology is used, the symbol shall be as defined in ISO/TR 15847.

9.2.1 Types of manual control devices

9.2.1.1 Flush control devices

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

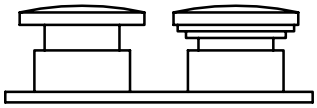
9.2.1.2 Guarded control devices

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.

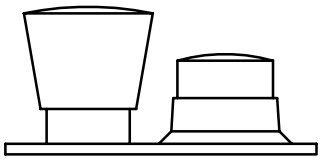
9.2.1.3 Mushroom-head and palm-type pushbuttons

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 18).

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



a) Mushroom-head pushbuttons



b) Palm-type pushbuttons

Figure 18 — Types of emergency stop pushbuttons

9.2.2 Colours for manual control devices

Colours used for control devices shall be as specified in Table 5.

Although Table 5 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 5.

The colour of the controls, illuminated or non-illuminated, shall be as specified in IEC 60204-1, 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 5 — Colours for manual control devices

Control	Required	Preferred	Remarks
Emergency stop	red on yellow background	—	—
Stop/safe	grey, black, white red, if used as emergency stop	red	red required in U.S.
Other motion stop	grey, black, white or red	red	red required 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, black, white or grey	blue	—
Faster	black, white or grey	grey	—
Slower	black, white or grey	white	—
Speed limit (see ISO 12643-2)	green, black, white or grey	green	used primarily on newspaper presses
Plate position (or comparable control) (see ISO 12643-2)	black, white or grey	grey	—
Other motion-initiating controls	black, white or grey	—	—

9.2.3 Functions, operations and mechanical specifications of manual control devices

9.2.3.1 Emergency stop

9.2.3.1.1 General

Emergency stops shall satisfy the requirements of ISO 13850 and IEC 60204-1.

9.2.3.1.2 Emergency stop function

The emergency stop function shall be able to be initiated by a single human motion.

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 Clause 7. 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 activation of the emergency stop control, 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 stop-button 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 function.

The emergency stop function shall not be bypassed.

The emergency stop function shall not be used as a substitute for safeguarding 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 may be necessary to ensure the continuing operation of auxiliary equipment such as braking devices.

9.2.3.1.3 Emergency stop devices

Emergency stop devices shall be designed in accordance with IEC 60204-1, either as a Category 0 stop or as a Category 1 stop.

EXCEPTION — If a.c. drives are used, the activation of an emergency stop control device may cause the drive to make a Category 2 stop, as defined in IEC 60204-1, if pulse blocking in the inverter and disconnection of the power to the control circuitry are separate functions, in accordance with Category 3 of ISO 13849-1:1999.

NOTE At the present time, NFPA 79 permits only Category 0 or Category 1 for emergency stops in the United States.

Every machine shall have at least one Category 0 stop. This may be satisfied by the requirements of IEC 60204-1.

Where a Category 0 stop is used for the emergency stop function, it shall have only hard-wired electromechanical components. In addition, its operation shall not depend on electronic logic (hardware or software) or the transmission of commands over a communications network or link.

Where a Category 1 stop is used for the emergency stop function, ultimate removal of power to the machine actuators shall be ensured and shall be by means of electromechanical components.

The emergency stop device shall be designed for easy actuation by the operator and others who may need to operate it.

Types of controls that may be used include

— mushroom-type or palm-type;

— wires, ropes, bars;

— handles;

— in specific applications, foot pedals without protective cover.

Keypads and touch screens shall not be used for emergency stop functions.

Emergency stop devices shall be provided on each machine unit, and at all operating positions in control zones where hazardous motion may exist (see 10.1.1).

Emergency stop devices shall be located on or within arm's reach of each motion-control station and operating position, and at other locations where the initiation of an emergency stop may be required. The emergency stop devices shall be positioned for easy access and for non-hazardous operation by the operator and others who may need to operate them.

The emergency stop device shall apply the principle of positive mechanical action. If a moving mechanical component inevitably moves another component along with it, either by direct contact or via rigid elements, these components are connected in the positive mode. An example of this is positive opening operation of switching devices in an electrical circuit.

NOTE Where a mechanical component moves and thus allows another one to move freely (e.g. by gravity, by spring force), there is no positive mechanical action of the first one on the other one.

An example of the application of this principle is an emergency stop device employing electrical contacts having positive opening operations. Positive opening operation of a contact element is the achievement of contact separation as the direct result of a specified movement of the switch actuator through non-resilient members (e.g. not dependent upon springs).

Once the emergency stop command has been generated as a result of actuation of the emergency stop device, the emergency stop command shall be maintained by engagement or latching-in of the actuating means. The emergency stop command shall be maintained until the emergency stop device is manually reset (unlatched). It shall not be possible for the control device to engage without generating the stop command.

In case of a failure in the emergency stop device (including the engagement mechanism), generation of the stop command shall have priority over the engagement means.

Actuation of an emergency stop control does not place the machine in the safe condition, unless it meets the criteria of a stop/safe function. Therefore, unless a stop/safe control has been activated, personnel warning lights or area warning lights shall not indicate a safe condition.

Resetting the emergency stop device shall not by itself generate a restart command.

It shall not be possible to restart the machine until all emergency stop devices that have been actuated are reset. The operator shall go through the normal starting sequence in order to initiate machine motion.

If a pushbutton is used as an emergency stop control, it shall comply with the provisions of IEC 60204-1.

A pushbutton used for emergency stop shall meet the criteria of a stop/safe pushbutton, including integration with the safety signalling system, if required. The use of an emergency stop control other than a pushbutton does not meet the requirements for the safe or safe-ready functions.

If an emergency stop device other than a pushbutton is used, its function shall be clearly identified by colour and labelling and its function shall comply with that specified in this subclause.

If using wires or ropes as emergency stop controls, consideration shall be given to the following:

— the amount of deflection necessary for generating the emergency stop command;

— the maximum deflection possible;

— the minimum clearance between the wire/rope and the nearest adjacent object;

— the force to be applied to the wire/rope (at maximum deflection) in order to engage the emergency stop device;

— making such wires/ropes visible for operators (e.g. by use of marker flags).

An emergency stop command shall be generated automatically in the event of disengagement, breakage or slack/sag in the wire/rope.

The reset mechanism for the emergency stop device should be placed so that the whole length of the wire or rope is visible from the location of the reset mechanism.

9.2.3.1.4 Emergency stop and auxiliary devices

For auxiliary devices built into system that require an emergency stop device according to this part of ISO 12643, the emergency stop buttons on the system shall function in accordance with the requirements of Clause 8.

The emergency stop function shall be designed so that after the actuation of the emergency stop control, 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 stop-button 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 function.

9.2.3.2 Stop/safe pushbutton

This part of ISO 12643 does not require that a stop/safe pushbutton be provided. However, if provided, it shall meet the provisions of this subclause.

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

Stop/safe functions shall be controlled only by the use of a stop/safe pushbutton as specified in this part of ISO 12643. Keypads and touch screens shall not be used for stop/safe functions.

The stop/safe pushbutton shall be an extended-head maintained-contact pushbutton which, when depressed, latches in the depressed position. In addition, it shall not be possible for the stop/safe control to mechanically engage without generating the stop command.

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. Releasing the stop/safe pushbutton shall place the machine in the ready condition if all guards are closed and all faults have been cleared. Otherwise, the machine shall revert to an unsafe condition, and no personnel warning lights shall be illuminated (see 13.2.4, Table 6). The operator shall go through the normal starting sequence in order to initiate machine motion.

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 control. If so used, it shall comply with the requirements for both the stop/safe and emergency stop functions and controls as defined in this part of ISO 12643, and shall be a mushroom-head or palm-type pushbutton.

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 may be necessary to ensure the continuing operation of auxiliary equipment such as clutches or braking devices.

9.2.3.3 Other motion stop control devices

Activating a stop control as defined in this subclause shall stop hazardous machine motion at least in the motion zone, or part of the motion zone, with which it is associated. A stop control 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 shall not be used for the stop/safe or emergency stop functions.

9.2.3.4 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 9.3.2 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 may be running at zero speed and/or may be in the armed condition.

NOTE A system may 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 13 and Annex C for the requirements of a warning period in systems using either a personnel warning-light signalling system or an area warning-light signalling system.

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

9.2.3.5 Inch control (jog)

9.2.3.5.1 Forward inch control

The forward inch control shall be a momentary-contact control that functions as described in 9.3.1, and moves the system in a forward direction.

The control shall be designed and mounted so as to minimize inadvertent operation. For example, this can be achieved by the use of a double-push activation as described in 9.3.1 b).

During the permissive period, the machine shall respond promptly to any inch control and shall continue to operate at inching speed as long as the control is depressed, or until the displacement limitation specified in 5.6 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 5.5.1 and 5.6.

The inch control may also be used to activate the reset function, which shall reset the machine and initiate a warning period as specified in Clause 13 and Annex C.

9.2.3.5.2 Reverse inch control

A reverse inch control shall be a momentary-contact guarded control. The control shall be designed and mounted so as to minimize inadvertent operation.

A reverse inch control initiates system motion at inch speed in a reverse direction as specified in 9.3.1.

9.2.3.5.3 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 9.3.1.

With the selector switch in the forward position, the inch control shall function in accordance with 9.2.3.5.1. With the selector switch in the reverse position, the inch control shall function in accordance with 9.2.3.5.2.

9.2.3.6 Reset

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

It is permitted to use the inch control to activate the reset function. In this case, the colour of the reset control shall conform with the colour requirements for the inch control. Motion controls shall not be enabled until all faults are cleared, all interlocks are made and all 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.

See 9.2.3.5.1 for use of an inch control to accomplish the reset function.

9.2.3.7 Faster control

A faster control shall be a momentary-contact control.

Depressing a faster control while the machine is in the run mode increases machine speed.

The faster control may also be used in conjunction with the inch control to initiate machine motion as defined in 9.3.2 at a minimum continuous run speed.

9.2.3.8 Slower control

A slower control shall be a momentary-contact control that decreases the speed of the system.

The slower control may also be used in conjunction with the inch control to initiate machine motion as defined in 9.3.2 at a minimum continuous run speed.

9.2.3.9 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.

9.3 Initiating machine motion

9.3.1 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.

9.3.2 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) activation of the run, the slower or the faster control with the inch control at the same motion-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) activation of the run, the slower or the faster device with the inch device at the same motion-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.

9.4 Hold-to-run controls

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

9.5 Two-hand controls

9.5.1 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 shall be taken as a basis (see 5.6 for hold-to-run devices designed as two-hand controls).

9.5.2 Two-hand controls on cables

Two-hand controls on cables (pendant-style control station) used for make-ready and trouble-shooting 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 is not applicable. Cables shall have sufficient strength to withstand any anticipated mechanical stresses and be provided with tension-relief measures.

9.5.3 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.

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.

9.6 Electro-sensitive protective devices

9.6.1 General requirements

Electro-sensitive protective devices (ESPDs) shall satisfy the requirements of Type 2 of IEC 61496-1 and IEC 61496-2.

EXCEPTION — Electro-sensitive protective devices that safeguard routine and regular access to the hazard zone on manually-fed devices, shall satisfy the requirements of Type 4 of IEC 61496-1 and IEC 61496-2.

9.6.2 Positioning of ESPDs

The hand-approach speed specified in ISO 13855 shall be used as a basis for determining the correct positioning of the electro-sensitive protective device.

9.6.3 Use of ESPDs to prevent whole-body access

Where electro-sensitive protective devices are used to prevent whole-body access to hazard zones, a minimum of two photoelectric beams shall be provided, one at a height of 400 mm and another at 900 mm.

9.7 Pressure-sensitive mats, pressure-sensitve bumpers, trip devices

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

Trip devices shall satisfy the requirements of EN 1760-2 and of Category 3 of ISO 13849-1:1999.

Trip devices and pressure-sensitive mats, and their related signal processing, which safeguard routine and regular access to a hazard point on a manually-fed device shall comply with Category 4 of ISO 13849-1:1999.

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 19).

9.8 Braking devices and clutches

9.8.1 Switch-off of braking device

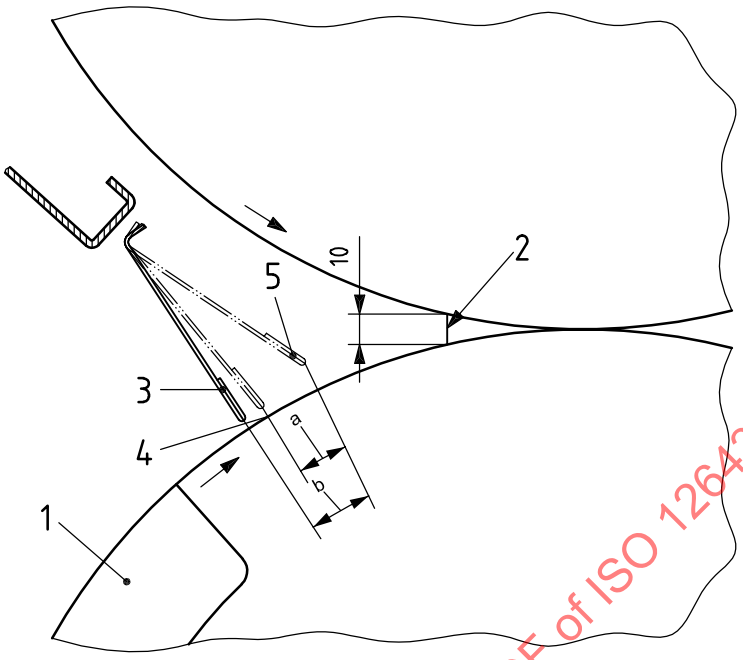
The braking device may be switched off only by either

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.

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 path of hazardous motion.
b Maximum length of movement of trip device.

Figure 19 — Trip devices

9.8.2 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.

10 Control stations

10.1 Motion-control stations

The use of a motion-control station is determined by the desired functions to be performed at its location. The contents and location (if necessary) of motion-control stations are specified in 10.1.1 and 10.1.2.

In a motion-control station, controls shall be arranged so that the emergency stop is readily accessible from an operating position.

The stop/safe may function as an emergency stop if it meets the criteria defined for an emergency stop.

In most cases, the emergency stop control is located closest to the operating position.

The respective order of controls should be uniform throughout the system. When a motion-control station is located with another (non-motion control) station, the functions of the motion-control station shall be distinctly set apart from the non-motion functions by spacing, marking or framing.

When a motion-control station contains both a motion control and a stop/safe pushbutton or emergency stop control, the stop/safe or emergency stop function shall affect the same machine or group of machines within the system affected by the motion control in that motion-control station.

The respective order of stop and motion controls should be uniform throughout the system. When a motion-control station includes a separate emergency stop function in addition to a separate stop/safe function, the emergency stop function shall be distinctly set apart by spacing, marking or framing.

10.1.1 Minimum motion-control station

Each operating position capable of initiating hazardous motion shall have an emergency stop function on or at the operating position.

EXCEPTION — If the control station contains only two-hand hold-to-run controls used to move the machine at inch speed, an emergency stop function on the control station is not required. However, the emergency stop function shall be provided in accordance with 9.2.3.1.3.

A motion-control station at a location where an operator has access to a hazard through a movable guard shall contain an emergency stop pushbutton or a stop/safe (if it serves as the emergency stop function).

A single stop/safe pushbutton that is also used as an emergency stop control may be used as long as it meets the requirements for both an emergency stop and a stop/safe pushbutton.

10.1.2 Motion-control station location

Motion-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).

Examples of routine, repetitive operations are clearing jams, adjusting operations, etc.

Every operating position of the system shall have a motion-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 hazardous zone, the only motion-initiating control permitted shall be a forward inch-control device and a reverse inch-control device as specified in 9.2.3.5.1, 9.2.3.5.2 and 5.6.

Emergency stop controls on operator and motion-control stations shall be pushbutton controls and shall latch in the safe condition.

Controls shall be easily viewed from the operating positions associated with that control station.

If a motion-control station is movable (not portable), the station shall be physically supported by a suitable means other than the electrical wiring.

Portable motion-control stations shall meet the same criteria as other motion-control stations. In addition, cables shall be protected from damage and shall not pose an additional hazard to personnel. If a portable motion-control station can extend into a hazardous zone in which the guard could be closed while the operator is within the hazardous zone, that control station shall not permit motion at a speed greater than that specified in 5.6.

10.2 Remote access

10.2.1 Remote control via datalink

10.2.1.1 General

Systems that utilize warning periods as defined in 13.2.2 and permissive periods as defined in 13.2.3 may use remote control communications links for the purposes of performing diagnostic and calibration functions, including those functions requiring remote activation of machine motion.

10.2.1.2 Maintaining system and data integrity

The equipment manufacturer or service provider shall take into consideration the following measures, and shall comply with Category 3 as specified in ISO 13849-1:1999, and/or the measures shall be accomplished by a computer system in accordance with Category 3 of ISO 13849-1:1999.

Measures shall be in place to perform the following.

— Guard against transmission of faulty data. Data integrity during transmission can be achieved, for example, by the implementation of a block protection process or other comparable measures with block replication. The size of the data block should not exceed 512 bytes. For every single block, at least a 16-bit cyclic redundancy check should be made. The selection of the polynomial should be such that the so-called burst errors are recognized by the cyclic redundancy check (CRC) algorithm. In the event of a CRC error, the faulty block should be rejected and be transmitted anew. The generator polynomial $P(x) = x^{16}+x^{15}+x^2+1$ is recommended as this 16-degree polynomial allows the recognition of all burst errors up to a length of 26 bits. Additionally, 99,996 % of all 17-bit errors and 99,998 5 % of all burst errors larger than 15 bits are recognized, including all odd-bit positions.

— Ensure that the remote control data link is connected to the intended system control computer. Identification of the system may be achieved, for example, by use of a unique machine-identification code, normally a multi-digit number. This number is posted in a safe portion of the control system and should be compared with the identification number associated with the remote transmission. The identification code should, for example, be checked by means of the CRC mechanism or comparable measures.

— Guard against the possibility of the establishment of unauthorized data links to the system control computer. Unauthorized entry to the system control computer may be prevented, for example, by requiring the use of a password and a subscriber identification with so-called transaction numbers which should contain at least a 64-bit coding method equivalent to those in on-line banking, and should also include a c heck of the unique machine identification.

10.2.1.3 Datalink line blocking

It shall be possible to disable (block) access to a local system control computer via a remote control datalink by disconnecting the remote control communications line connection to the system control computer.

There shall be a minimum of two such disconnects as follows:

— a switch (safety relay) controlled by the safety-guard interlock system (see 5.5.5);

— a manually operated switch requiring a key or a password to close the connection.

10.2.1.4 Indication of enabled condition of remote control datalink

Whenever the power supply to the local system control computer is ON and the capability exists for remote control communications link to be enabled (unblocked), there shall be a method to alert personnel at the local system of the enabled condition.

NOTE This can be achieved, for example, by either indicator light(s) on one or more control stations, or a notification message on a display screen(s).

10.2.1.5 Indication of activated condition of remote control datalink

Whenever a remote control communications link has been established to the local system control computer, there shall be a method to alert personnel at the local system of the active condition of the remote control datalink.

NOTE This can be achieved, for example, by either blinking indicator light(s) on one or more control stations, or a blinking notification message on a display screen(s).

10.2.1.6 Remote control use of warning and permissive periods

A remote control datalink shall not be able to initiate machine motion without the use of the same warning and permissive periods defined in 13.2.2 and 13.2.3 and in effect during normal local operation of that system.

10.2.1.7 Response to motion command from remote control datalink

The design of the system controls shall require that every command initiated by the remote control datalink that causes the system to enter warning and permissive periods for machine motion shall be responded to by a local manually generated ready signal issued within the warning or permissive periods before motion may begin.

It shall not be possible to initiate motion by remote control on any equipment for which hold-to-run control serves as the only hazard protection. Remote control shall not override any safety-related functions.

Failure to receive the local ready signal shall cause the system to stop under the same conditions, and with the same effects, as a trip of the system safety-guard interlock system, including blocking the datalink line.

10.2.1.8 Remote control datalink time-out

The system shall be equipped with a time-out function which, when a remote control data link is established, will cause the system to stop under the same conditions and with the same effects (including blocking of the datalink line) as a trip of the system safety-guard interlock system if the time-out function is not reset manually by local personnel within a period of less than 30 min from the last manual reset.

10.2.1.9 Acceptance safety test for software changes

If risk assessment determines that a software change may potentially affect safety functions of a machine, (an) authorized person(s) shall conduct a comprehensive acceptance safety test at the machine (not by remote access) on the basis of broad functional tests of the safety functions that may be affected by the newly recorded data. The manufacturer (or manufacturer's agent) shall provide detailed instructions to the authorized person(s) at the installation site (for example, in the form of checklists) for this acceptance test.

The machine may be returned to operation after successful completion of the on-site test(s).

The process for the acceptance-test procedure and the subsequent return of the machine to service shall be documented in a protocol, which shall be recorded by the responsible authorized person(s) at the machine site and retained by the manufacturer.

10.2.2 Wireless motion-control stations

Although wireless control is not generally used to control production motion of equipment, it is recognized that there are operations for which it is desirable. This subclause addresses the minimum requirements for such controls, if they are used.

Wireless motion controls shall be permitted only under the following conditions and shall meet the following requirements.

a) Wireless motion controls shall be used only if the equipment to be controlled is in full compliance with all requirements of this part of ISO 12643.

b) The emergency stop control shall remain functional at all times and shall override all functions, both local and remote.

c) Controls shall be designed so as to allow sending a signal only on an unobstructed path to a receiver, and shall require that the operator be in direct line-of-sight of the equipment being moved; i.e. with no machinery, walls or other objects blocking the operator's ability to see the equipment being moved.

d) Each motion-control station that is not attached to the machine it controls shall carry a clear indication of which machine is controlled by that control station.

e) The controls meet the requirements specified in Clause 9.

f) The wireless control station shall contain a control which, when activated, shall generate an emergency stop command. As specified in 9.2.3.1.3, generation of an emergency stop command does not place the machine in the safe condition and the warning lights shall not indicate a safe condition. Therefore, this control shall not be labelled as an emergency stop control or a stop/safe control. Following such a stop, the machine shall go through a normal starting sequence before motion can be initiated.

EXCEPTION — If the wireless control station contains only hold-to-run controls used to move the machine at inch speed with all guards closed, a stop control on the control station is not required.

g) Measures shall be taken to ensure that control commands affect only the intended machines and machine functions.

h) Measures shall be taken to prevent the machine from responding to signals other than those from the intended motion-control station(s).

i) Any fault or single-point failure in a wireless control station shall result in the automatic initiation of a stop command, which shall stop the machine as quickly as possible without creating a hazard or damaging the machine, and shall prevent potentially hazardous operation. Such a stop does not place the machine in the safe condition. Following such a stop, the machine shall go through a normal starting sequence before motion can be initiated.

EXAMPLE An example of such a failure is when a valid signal has not been detected within a specified period of time.

j) In a machine where the control of safety-related functions relies on serial data transfer, correct communications shall be ensured by using an error-detection method that is able to cope with up to three error bits in any command sequence.

k) On battery-powered control stations, a variation in the battery voltage shall not cause a hazardous condition. If one or more potentially hazardous motions are controlled using a battery-powered motion-control station, a clear warning shall be given to the operator when a variation in battery voltage exceeds specified limits. Under those circumstances, the motion-control station shall remain functional long enough to put the machine into a non-hazardous condition.

Instructions on the use of wireless control shall be included in the instruction handbook. These instructions shall provide the basis for training of authorized personnel.

11 Control systems

11.1 General requirements

11.1.1 Hydraulic, pneumatic, electric and electronic control systems

On hydraulic/pneumatic control systems, the safety-related parts shall comply with the requirements for Category 1 of ISO 13849-1:1999. On the electric/electronic control system, the safety-related parts shall comply with the requirements for Category 3 of ISO 13849-1:1999. Single main power contactors that comply with the requirements for Category 1 of ISO 13849-1:1999 may be used.

NOTE The single-fault requirement of Category 3 of ISO 13849-1:1999 can be achieved, for example, by redundant hard-wired circuits, a combination of a hard-wired circuit and an electronic circuit, or multiple electronic circuits with multiples PLCs or processors.

Faults in the auxiliary relays and contactors of the control circuit shall be detected and cause the machine to shut down. When computers, modems or programmable logic controls (PLCs) are used, safety-related malfunctions shall be detected and shall cause the machine to shut down.

When computers, modems or PLCs are used, this requirement may be satisfied, for example, by monitoring the function of safety-related signals using parallel control systems or redundant contact-type circuit breaking principles.

Safety-related parts of control systems include, for example, emergency stop circuits, electric interlocking circuits, limiters of displacement or operating speed on hold-to-run controls. (See also ISO 13849-1:1999 for definitions.)

External influences as well as faults in the control system could result in hazardous movements and hazards. Examples of hazardous movements, depending on the type of machine, include the following:

— unintended start-up;

— unintended speed increase up to production speed with a guard open;

— unintended movement following an intended movement (unintended cycle);

— unintended continuation of a movement when the movement is intended to stop.

The build-up of potentially explosive atmospheres might constitute a hazard.

11.1.2 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.

“Safety devices” include, for example, emergency stop devices, electro-sensitive protective devices, and trip devices.

“Other appropriate measures” include, for example, 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 For example, on electronic adjustable speed drives, the speed of rotation of the motor is changed by shifting the supply voltage and/or frequency.

11.1.3 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 meet at least Category 1 of ISO 13849-1:1999, 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.

11.1.4 Residual-pile monitoring systems

A residual-pile monitoring system that is also used as a safety device shall comply with the requirements of at least Category B of ISO 13849-1:1999.

11.1.5 Unobserved unguarded hazard zones

When more than one interlocking guard is open and there are any unguarded hazard zones that cannot be observed from a single point of operation, the circuits controlling mutual interlocking of safety devices that prevent machine motion under hold-to-run condition shall comply with the requirements of at least Category 1 of ISO 13849-1:1999. The interlocking may be computer controlled.

For areas that are not visible from the operating position, see 5.7.1.

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 comply with the requirements of 11.1.

11.2 Additional requirements for hand-fed machines where the operator's hands enter the point of operation

11.2.1 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 11.2.2 to 11.2.5 shall apply.

For example, this may apply to certain platen and screen presses, guillotine cutters, hand-fed trimmers and hand-fed label punching machines.

11.2.2 Hydraulic/pneumatic control system

The safety-related parts of the hydraulic/pneumatic control system shall comply with the requirements of Category 3 of ISO 13849-1:1999.

11.2.3 Electric/electronic control system

The safety-related parts of the electric/electronic control system shall comply with the requirements of Category 4 of ISO 13849-1:1999.

11.2.4 Main contactors

Main contactors shall be redundant. Faults in the main contactors shall be detected and shall lead to shutdown.

11.2.5 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. The mechanical-brake torque shall be greater than the maximum electric-drive torque of the electronic drive.

NOTE For example, electronic brakes exist on electronic drives where the braking effect is caused by energy being fed back into the circuit.

12 Ergonomics and labelling of indicators and actuators

Unless otherwise specified in this part of ISO 12643, the ergonomic design and labelling requirements relating to indicators and actuators shall comply with the requirements as specified in IEC 61310-1, IEC 61310-2 and IEC 61310-3.

13 Signals and warning devices

13.1 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 may 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 defined in 13.2, or an area warning-light system as described in Annex C, shall be used. A warning system using an audible alarm is preferred. 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 13.2.6.

NOTE 2 The audible alarm system is required in Europe by EN 1010-1[35].

Optional personnel warning lights as defined in 13.2.4 may be used in addition to an audible alarm.

NOTE 3 In some countries, such as in the United States, the use of personnel warning lights is required by ANSI B65[54][55] standards unless the area warning light system is used. In such cases, national requirements take precedence over this part of ISO 12643.

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, but are not required. If personnel warning lights are used, their independent operation is optional (see Clause 8).

13.2 Audible warning system

13.2.1 Audible alarm

The audible warning system shall consist of an audible alarm, a warning period and a permissive period. Different audible characteristics may be used to distinguish between different machines.

13.2.2 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 may need to 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 may 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.

13.2.3 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 may 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, the machine shall revert to the ready condition and a new warning period is required before further machine motion.

It is permissible to use a combination of double-push and single-push to initiate inch and run.

For example, for production reasons it may be preferable to use the double-push system to initiate inch, but a single-push system to initiate run.