BRITISH STANDARD

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953:1997
+A1:2009

Safety of machinery — Guards — General requirements for the design and construction of fixed and movable guards

ICS 13.110

National foreword

This British Standard is the UK implementation of EN 953:1997+A1:2009. It supersedes BS EN 953:1997 which is withdrawn.

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to CEN text carry the number of the CEN amendment. For example, text altered by CEN amendment A1 is indicated by ⟩A1 ⟨A1.

The UK participation in its preparation was entrusted to Technical Committee MCE/3, Safeguarding of machinery.

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

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EUROPEAN STANDARD

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EUROPÄISCHE NORM

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ICS 13.110

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English Version

Safety of machinery - Guards - General requirements for the design and construction of fixed and movable guards

Sécurité des machines - Protecteurs - Prescriptions générales pour la conception et la construction des protecteurs fixes et mobiles

Sicherheit von Maschinen - Trennende Schutzeinrichtungen - Allgemeine Anforderungen an Gestaltung und Bau von feststehenden und beweglichen trennenden Schutzeinrichtungen

This European Standard was approved by CEN on 26 March 1997 and includes Amendment 1 approved by CEN on 8 February 2009.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN Management Centre has the same status as the official versions.

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Foreword

This document (EN 953:1997+A1:2009) has been prepared by Technical Committee CEN/TC 114 “Safety of machinery”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2009, and conflicting national standards shall be withdrawn at the latest by December 2009.

This document includes Amendment 1, approved by CEN on 2009-02-08.

This European Standard supersedes EN 953:1997.

The start and finish of text introduced or altered by amendment is indicated in the text by tags [A1⟩ ⟨A1].

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

[A1⟩ For relationship with EU Directive(s), see informative Annexes ZA and ZB, which are integral parts of this document. ⟨A1]

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

Introduction

This European Standard specifies general principles for the design and construction of guards, both fixed and movable. It is intended for use by manufacturers, designers, standards makers and other interested parties.

〉A1〈 This document is a type B standard as stated in EN ISO 12100-1.

The provisions of this document can be supplemented or modified by a type C standard.

NOTE For machines which are covered by the scope of a type C standard and which have been designed and built according to the provisions of that standard, the provisions of that type C standard take precedence over the provisions of this type B standard. 〈A1〉

In accordance with the requirements laid down in 〉A1〈 EN ISO 12100-1 〈A1〉 and 〉A1〈 EN ISO 12100-2 〈A1〉 the machine designer shall identify the hazards present at a machine, carry out a risk assessment and reduce risk by design before considering safeguarding techniques.

1 Scope

This European Standard specifies general requirements for the design and construction of guards provided primarily to protect persons from mechanical hazards.

The standard applies primarily to machines which are manufactured after the date of issue of this standard.

Attention is drawn to the use of guards to minimise exposure to non-mechanical hazards.

The requirements are applicable if fixed and movable guards are used. The standard does not cover those parts of guards which actuate interlocking devices. These are covered in EN 1088.

This standard does not provide requirements for special systems relating specifically to mobility and ability to lift loads like rollover protective structures (ROPS) and falling-object protective structures (FOPS).

2 Normative references

〉A1〈 The following referenced documents are indispensable for the application of this European Standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies. 〈A1〉

〉A1〈 *deleted text* 〈A1〉

EN 349, *Safety of machinery – Minimum gaps to avoid crushing of parts of the human body*

EN 626-1, *Safety of machinery – Reduction of risks to health from hazardous substances emitted by machinery – Part 1: Principles and specifications for machinery manufacturers*

〉A1〈 *deleted text* 〈A1〉

EN 1088, *Safety of machinery – Interlocking devices associated with guards – Principles for design and selection*

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

EN 1672-2, *Food processing machinery – Basic concepts – Part 2: Hygiene requirements*

EN 60204-1, *Safety of machinery – Electrical equipment of machines – Part 1: General requirements* ⟦A1⟩ *(IEC 60204-1:2005, modified)* ⟨A1⟧

⟦A1⟩ EN ISO 12100-1:2003, *Safety of machinery – Basic concepts, general principles for design – Part 1: Basic terminology, methodology (ISO 12100-1:2003)* ⟨A1⟧

⟦A1⟩ EN ISO 12100-2:2003, *Safety of machinery – Basic concepts, general principles for design – Part 2: Technical principles (ISO 12100-2:2003)* ⟨A1⟧

⟦A1⟩ EN ISO 13857, *Safety of machinery – Safety distances to prevent hazard zones being reached by upper and lower limbs (ISO 13857:2008)* ⟨A1⟧

⟦A1⟩ EN ISO 14121-1, *Safety of machinery – Risk assessment – Part 1: Principles (ISO 14121-1:2007)* ⟨A1⟧

Additional information is given in ⟦A1⟩ the Bibliography ⟨A1⟧.

3 Definitions

⟦A1⟩ For the purposes of this document, the terms and definitions given in EN ISO 12100-1:2003 and the following apply. ⟨A1⟧

3.1
guard
⟦A1⟩ physical barrier, designed as part of the machine, to provide protection

NOTE 1 A guard may act:

— alone; it is then only effective when it is "closed" for a movable guard or "securely held in place" for a fixed guard;

— in conjunction with an interlocking device with or without guard locking; in this case, protection is ensured whatever the position of the guard.

NOTE 2 Depending on its design, a guard may be called e.g. casing, shield, cover, screen, door, enclosing guard.

NOTE 3 See EN ISO 12100-2:2003, 5.3.2 and EN ISO 12100-2:2003/prA1:2008, 5.3.2.4 for types of guards and their requirements.

[EN ISO 12100-1:2003, 3.25] ⟨A1⟧

3.2
fixed guard
⟦A1⟩ guard affixed in such a manner (e.g. by screws, nuts, welding) that it can only be opened or removed by the use of tools or destruction of the affixing means

[EN ISO 12100-1:2003, 3.25.1] ⟨A1⟧

3.2.1
enclosing guard
guard which prevents access to the danger zone from all sides (see figure 1)

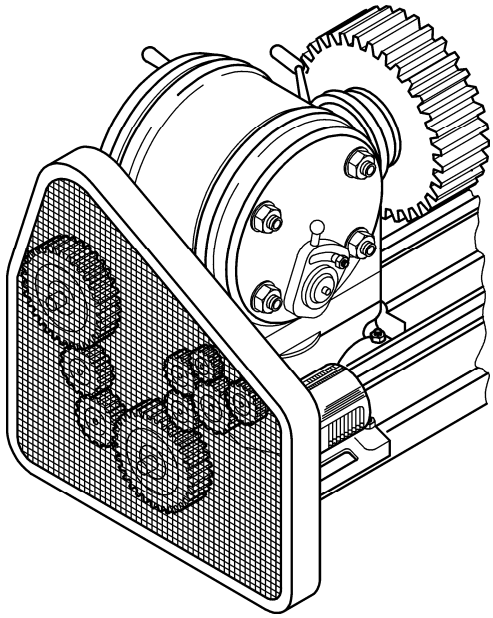


Figure 1 — Example of an enclosing guard totally preventing access to transmission machinery

3.2.2
distance guard
guard which does not completely enclose a danger zone, but which prevents or reduces access by virtue of its dimensions and its distance from the danger zone, e.g. perimeter fence or tunnel guard (see figures 2 and 3)

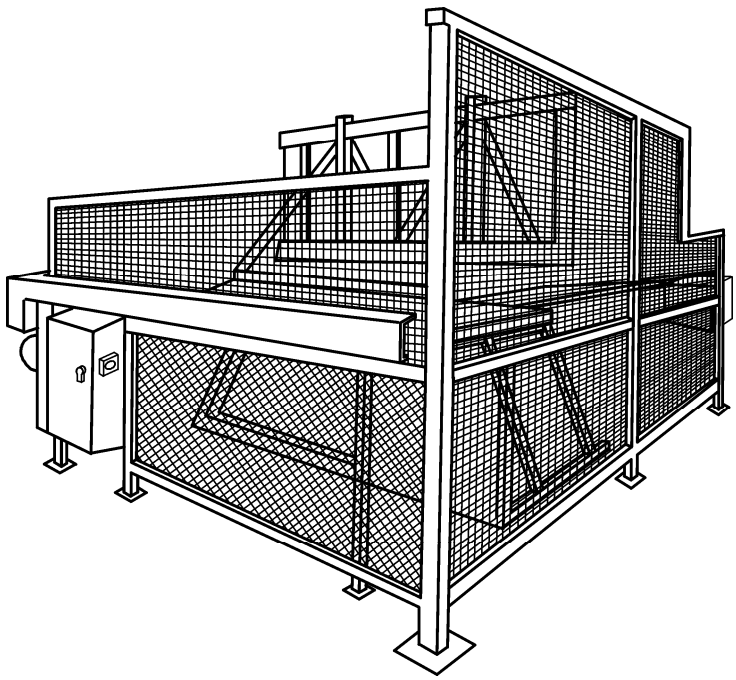


Figure 2 — Example of a distance guard

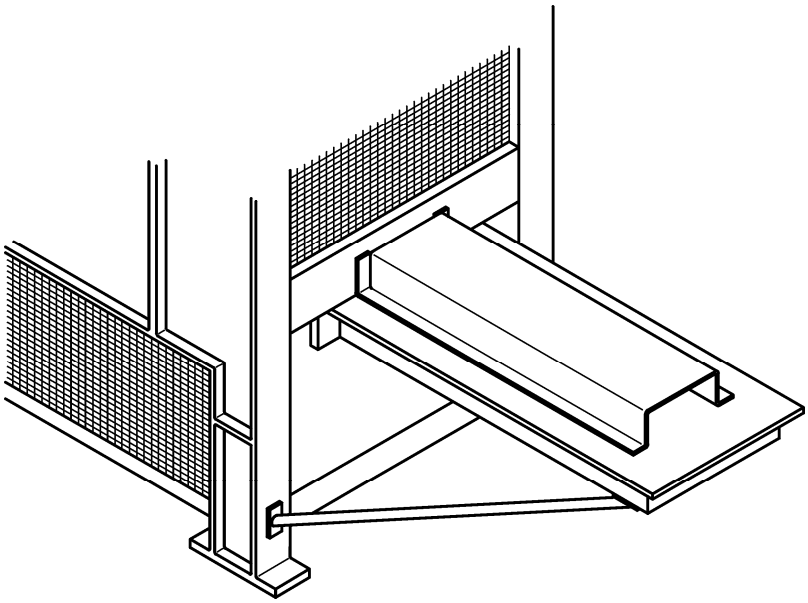


Figure 3 — Example of a distance guard: tunnel guard providing protection at machine feed or discharge area

3.3
movable guard
〚A1〛 guard which can be opened without the use of tools

[EN ISO 12100-1:2003, 3.25.2] 〈A1〛

3.3.1
power operated guard
movable guard that is operated with the assistance of power from a source other than persons or gravity

3.3.2
self closing guard
movable guard operated by a machine element (e.g. moving table) or by the workpiece or a part of the machining jig, so that it allows the workpiece (and the jig) to pass and then automatically returns (by means of gravity, a spring, other external power, etc.) to the closed position as soon as the workpiece has vacated the opening through which it has been allowed to pass 〚A1〛 *deleted text* 〈A1〛

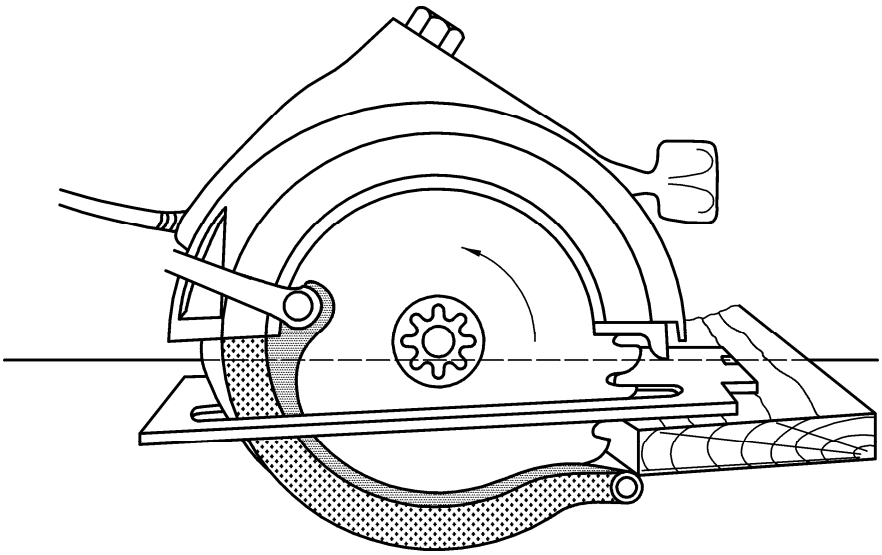


Figure 4 — Example of a self closing guard

3.3.3
control guard
〚A1〛 special form of an interlocking guard which, once it has reached its closed position, gives a command to initiate the hazardous machine function(s) without the use of a separate start control

NOTE EN ISO 12100-2:2003, 5.3.2.5, gives detailed provisions regarding the conditions of use.

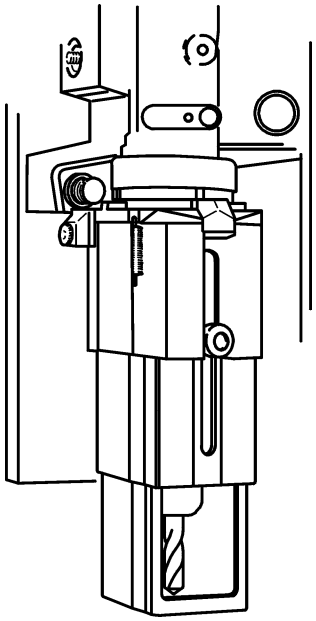
[EN ISO 12100-1:2003, 3.25.6] 〈A1〉

3.4
adjustable guard
〚A1〛 fixed or movable guard which is adjustable as a whole or which incorporates adjustable part(s)

[EN ISO 12100-1:2003, 3.25.3 and EN ISO 12100-1:2003/prA1:2008] 〈A1〉

〚A1〛 **3.4.1**
manually adjustable guard
adjustable guard where the adjustment is made manually and the adjustment remains fixed during a particular operation

NOTE See also Figure 5. 〈A1〉



The guard is telescopic to provide ready adjustment to the surface of the workpiece. It is attached to a hinge to permit access to the spindle for drill changing.

Figure 5 — Example of an adjustable guard for a radial or pedestal drilling machine

〈A1〉 3.4.2
automatically adjustable guard
adjustable guard where the adjustment is made automatically during a particular operation

NOTE A self closing guard can also be an automatically adjustable guard. 〈A1〉

3.5
interlocking guard
〈A1〉 guard associated with an interlocking device so that, together with the control system of the machine, the following functions are performed:

— the hazardous machine functions "covered" by the guard cannot operate until the guard is closed;

— if the guard is opened while hazardous machine functions are operating, a stop command is given;

— when the guard is closed, the hazardous machine functions "covered" by the guard can operate. The closure of the guard does not by itself start the hazardous machine functions

NOTE ISO 14119 gives detailed provisions.

[EN ISO 12100-1:2003, 3.25.4]

(See also Figure 6 and Figure 7 and EN 1088.) 〈A1〉

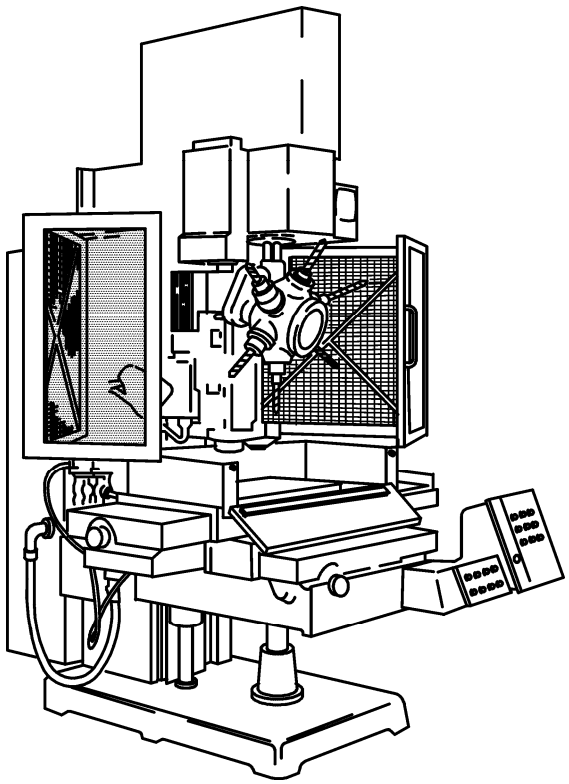


Figure 6 — Example of interlocking hinged guards; these enclose the danger zone when closed

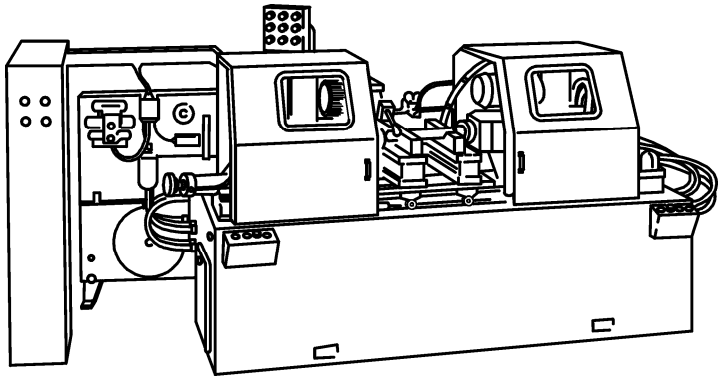


Figure 7 — Example of interlocking sliding guards

3.6
interlocking guard with guard locking
〈A1〉 guard associated with an interlocking device and a guard locking device so that, together with the control system of the machine, the following functions are performed:

— the hazardous machine functions “covered” by the guard cannot operate until the guard is closed and locked;

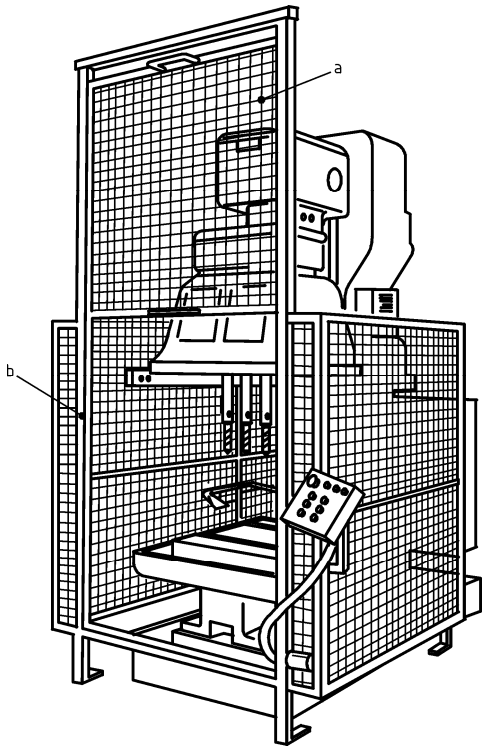
— the guard remains closed and locked until the risk due to the hazardous machine functions "covered" by the guard has disappeared;

— when the guard is closed and locked, the hazardous machine function "covered" by the guard can operate. The closure and locking of the guard do not by themselves start the hazardous machine functions.

NOTE ISO 14119 gives detailed provisions.

[EN ISO 12100-1:2003, 3.25.5]

(See also Figure 8 and EN 1088.) A1



a) Interlocking guard in the open position
b) Example of guard locking device

Figure 8 — Example of safeguarding of drilling machine using interlocking guards with guard locking and fixed guards

3.7
guard closed position
a guard is closed when it performs the function for which it was designed to prevent/reduce access to the danger zone and/or reduce exposure to hazards such as noise, radiation etc.

3.8
guard open
a guard is open when it is not closed

3.9
tool
implement such as a key or wrench designed to operate a fastener. An improvised implement such as a coin or nailfile cannot be considered to be a tool

3.10
use of a tool
use of a tool by an authorised person under known and predetermined circumstances as part of a safe system of work

3.11
frequency of access
number of occasions on which access is required or foreseeable within the guarded area per unit of time.

4 Risk assessment

In order to select and design types of guards appropriate to particular machinery, it is important to assess the risk arising from the various hazards present at that machinery and the foreseeable categories of persons at risk ▌A1⟩ (see EN ISO 12100-1:2003, Clause 5 and EN ISO 14121-1) ⟨A1▌.

5 Principal requirements for the design and construction of guards

5.1 Machine aspects

5.1.1 General

Proper consideration of foreseeable aspects of the machine environment and operation throughout the foreseeable life of the machine is necessary in the design and application of guards. Inadequate consideration of these aspects can lead to unsafe or inoperable machinery. This in turn can lead persons to defeat the guards provided thus exposing them to greater risk.

5.1.2 Access to danger zones

To minimise access to danger zones where practicable, guards and machinery shall be so designed as to enable routine adjustments, lubrication and maintenance to be carried out without opening or removing the guards.

Where access is required within the guarded area this shall be as free and unobstructed as practicable. The following are examples of reasons for access.

— Loading and unloading

— Tool changing and setting;

— Measurement, gauging and sampling;

— Process observation;

— Maintenance and repair;

— Lubrication;

— Removal of waste material (e.g. scrap, swarf, spillage);

— Obstruction removal;

— Cleaning and hygiene.

5.1.3 Containment of ejected parts

Where there is a foreseeable risk of ejection of parts (e.g. broken tooling, workpiece) from the machine, the guard shall as far as practicable be designed and constructed from appropriate materials selected to contain these.

5.1.4 Containment of hazardous substances

Where there is a foreseeable risk of emission from the machine of hazardous substances (e.g. coolant, vapours, gases, swarf, sparks, hot or molten material, dust), the guard shall be designed to contain these as far as practicable and suitable extraction equipment can be needed (see EN 626-1).

If a guard forms part of an extraction system this function shall be considered in the design, selection of materials, construction and positioning of the guard.

5.1.5 Noise

Where a requirement has been established to reduce machine noise, guards shall be designed and constructed which will give the required noise reduction as well as providing protection against the other hazards present at the machine (⟨A1⟩ reference: see Bibliography ⟨A1⟩). Guards acting as acoustic enclosures shall have adequately sealed joints to reduce the emission of noise.

5.1.6 Radiation

Where there is a foreseeable risk of exposure to hazardous radiation, guards shall be designed and appropriate materials selected to protect persons from the hazard. Examples include the use of darkened glazing to prevent weldflash or the elimination of openings in a guard around a laser (⟨A1⟩ reference: see Bibliography ⟨A1⟩).

5.1.7 Explosion

Where there is foreseeable risk of explosion, guards shall be designed to contain or dissipate the released energy in a safe manner and direction (e.g. by use of "explosion relief" panels) (reference: EN 1127-1).

5.2 Human aspects

5.2.1 General

Reasonably foreseeable aspects of human interaction with machinery (e.g. when loading, maintaining or lubricating) shall be given proper consideration in the design and construction of guards.

5.2.2 Safety distances

Guards intended for preventing access to danger zones shall be designed, constructed and positioned to prevent parts of the body from reaching danger zones ⟨A1⟩ (see also EN ISO 13857) ⟨A1⟩.

5.2.3 Control of access to the danger zone

As far as practicable movable guards shall be designed and positioned such that during normal operation they are prevented from closing with persons in the danger zone. Where this is not practicable, other means shall be used to prevent persons remaining undetected within the danger zone.

5.2.4 Viewing

To minimise the need to remove them, guards shall be designed and constructed to offer adequate viewing of the process.

5.2.5 Ergonomic aspects

Guards shall be designed and constructed taking into account ergonomic principles ⟨A1⟩ (see also EN ISO 12100-2:2003, 4.8.2 and 4.8.3) ⟨A1⟩.

5.2.5.1 Size and weight

Removable sections of guards shall be designed to be of a suitable size and weight to permit ease of handling. Guards which cannot readily be moved or transported by hand shall be provided, or be capable of being provided with suitable attachment devices for transport by means of lifting gear. The attachments or provisions can be, for instance:

— Standard lifting appliances with slings, hooks, eyebolts or simply tapped holes for appliance fixing;

— Appliances for automatic grabbing with a lifting hook, when securing is not possible from the ground;

— Lifting gear and appliances integrated into the guard;

— An indication, on the guard itself and on some of its removable parts or in the information for use, of the value of their mass expressed in kilograms (kg).

5.2.5.2 Operating forces

Movable guards or removable sections of guards shall be designed to permit ease of operation.

The observance of ergonomic principles in designing guards contributes to increasing safety by reducing stress and the physical effort of the operator. This improves the performance and reliability of the operation, thereby reducing the probability of errors at all stages of machine use [A1] *deleted text* [A1].

Operating forces can be reduced by the use of devices such as springs, counterbalances or gas struts.

Where guards are power operated they shall not be capable of causing injury (e.g. from contact pressure, force, speed, sharp edges). Where a guard is fitted with a protective device which automatically initiates re-opening of the guard, the force to prevent the guard closing shall not exceed 150 N. The kinetic energy of the guard shall not exceed 10 J. Where no such protective device is fitted these values shall be reduced to 75 N and 4 J respectively.

5.2.6 Intended use

Guards shall be designed so far as is practicable to take into account foreseeable use and reasonably foreseeable misuse [A1] (see EN ISO 12100-1:2003, 3.22 and 3.23) [A1].

5.3 Guard design aspects

5.3.1 General

All foreseeable aspects of guard operation shall be given proper consideration at the design stage to ensure that the design and construction of the guard itself does not create a further hazard.

5.3.2 Crushing or trapping points

Guards shall be designed so as not to cause hazardous crushing or trapping points, with parts of the machine or of other guards (see also EN 349).

5.3.3 Durability

Guards shall be designed to perform their function properly throughout the foreseeable life of the machine or provision made for replacement of degradable parts.

5.3.4 Hygiene

Where applicable, guards shall be designed so as not to create hazards to hygiene by trapping items or material, e.g. food particles, stagnant fluids (see EN 1672-2).

5.3.5 Cleaning

Guards used in certain applications, notably for the processing of food and pharmaceuticals shall be so designed that they are not only safe to use but can be readily cleaned.

5.3.6 Exclusion of contaminants

Where it is a requirement of the process, guards shall be designed to exclude contaminants from the process, e.g. in the food, pharmaceutical, electronic and related industries.

5.4 Guard construction aspects

The following aspects shall be considered in determining the methods to be used for the construction of guards.

5.4.1 Sharp edges etc.

Guards shall be constructed so as not to have exposed sharp edges and corners or other hazardous projections.

5.4.2 Integrity of joints

Welded, bonded or mechanically fastened joints shall be of sufficient strength to suit reasonably foreseeable loading. Where bonding agents are used, these shall be compatible with the process and materials being used. Where mechanical fastenings are used, their strength, number and spacing shall be sufficient to ensure the stability and rigidity of the guard.

5.4.3 Removal only by tool

Demountable parts of guards shall only be removable with the aid of a tool (see 3.9 and 3.10).

5.4.4 Positive location of removable guards

Where practicable, removable guards shall be unable to remain in place without their fixings.

5.4.5 Positive closing of movable guards

The closed position of movable guards shall be determined positively. The guard shall be held in position against a stop by means of gravity, a spring, catch, guard locking device or other means.

5.4.6 Self closing guards

The self closing guard opening shall be limited to no more than that required for the passage of the workpiece. It shall not be possible to lock the guard in its open position. These guards can be used in conjunction with fixed distance guards.

5.4.7 Adjustable guards

5.4.7.1 〈A1〉 General

Adjustable guards shall be such as to enable the opening to be restricted to a minimum consistent with the passage of material.

5.4.7.2 Manually adjustable guard

Manually adjustable guards shall

— be designed and constructed so that the adjustment remains fixed during a given operation;

— be readily adjustable without the use of tools.

5.4.7.3 Automatically adjustable guard

Automatically adjustable guards shall be designed and constructed so that the gap between the guard and the material is always limited to the minimum that is necessary for the work. 〈A1〉

5.4.8 Movable guards

Opening of movable guards shall require positive action and where practicable movable guards shall be attached to the machine or adjacent fixed elements so that they are retained, e.g. by hinges or slides, even when open. Such attachments shall only be removable with the aid of a tool (see 3.9 and 3.10).

5.4.9 Control guards

Control guards 〈A1〉 (see 3.3.3 of this standard and EN ISO 12100-2:2003, 5.3.2.5) 〈A1〉 may be used only if all the following conditions are fulfilled:

— There is no possibility for an operator or a part of his body to stay in the danger zone or between the danger zone and the guard while the guard is closed;

— Dimensions and shape of the machine allow for the operator or any person having to intervene on the machine to have a global view of the whole machine/process;

— Opening the control guard or an interlocking guard is the only way to enter the danger zone;

— The interlocking device associated with the control guard is of the highest possible reliability (as its failure can lead to an unintended/unexpected start up);

— Where starting the machine with a control guard is one of the possible control modes of the machine, mode selection shall be ensured according to 〈A1〉 EN ISO 12100-2:2003, 4.11.10 〈A1〉.

NOTE The danger zone considered above is any zone where the operation of hazardous elements is initiated by closure of the control guard.

5.5 Selection of materials

5.5.1 General

The following aspects shall be considered in the selection of suitable materials for the construction of guards. These properties shall be maintained throughout the foreseeable life of the guard.

5.5.2 Impact resistance

Guards shall be designed to withstand reasonably foreseeable impacts from parts of machinery, workpiece, broken tooling, ejected solid or fluid matter, impact by the operator, etc. Where guards are fitted with viewing panels, special consideration shall be given to the selection of materials and method of fixing these. Materials shall be selected with properties suited to resist the mass and velocity of the ejected object or material.

5.5.3 Rigidity

Support posts, guard frames and infill materials shall be selected and arranged to provide a rigid and stable structure and to resist deformation. This is especially important where deformation of material could be detrimental to maintaining safety distances.

5.5.4 Secure fixing

Guards or parts of guards shall be secured by fixing points of adequate strength, spacing and number to remain secure under any foreseeable loading. Fixing can be by means of mechanical fasteners or clamps, welded or bonded joints or other means suited to the application.

5.5.5 Reliability of moving parts

Moving parts, e.g. hinges, slides, handles, catches, shall be selected to ensure reliable operation given their foreseeable usage and working environment.

5.6 Containment

Harmful substances, e.g. fluids, swarf, dust, fumes, which can reasonably be foreseen, shall be contained within the guard by suitable impermeable material (〚A1〛 reference: see Bibliography 〈A1〉).

5.7 Resistance to corrosion

Materials shall be selected which are resistant to foreseeable oxidation and corrosion from the product, process or environmental factors, e.g. from cutting fluids in machining operations or cleaning and sterilising agents in food processing machinery. This can be achieved by the application of suitable protective coatings.

5.8 Resistance to micro-organisms

Where there is a foreseeable risk to health from bacterial and fungal growth, such as in the food, pharmaceutical and related industries, materials used in the construction of guards shall be selected that inhibit this growth and can be easily cleaned and if necessary disinfected.

5.9 Non-toxicity

Materials and finishes used shall be non-toxic in all foreseeable conditions of use and compatible with the process involved especially in food, pharmaceutical and related industries.

5.10 Machine viewing

Where viewing of machine operation is required through the guard, materials shall be selected with suitable properties, e.g. if perforate material or wire mesh is used this should be of adequate open area and suitable colour to permit viewing. Viewing will be enhanced if the perforate material is darker than the area observed.

5.11 Transparency

As far as practicable, materials used for viewing machine operation shall be selected from those which retain their transparency, with age and use. Guards shall be designed to make provision for the replacement of degraded materials.

Certain applications can require the selection of materials or combinations of materials that are resistant to abrasion, chemical attack, degradation by ultra violet radiation, dust attraction by static electrical charge, or surface wetting by fluids which impair transparency.

5.12 Stroboscopic effects

Where there is a foreseeable hazard from stroboscopic effect, materials shall be selected which minimise this occurrence.

5.13 Electrostatic properties

Certain applications can require the selection of materials that do not retain an electrostatic charge, in order to avoid an accumulation of dust and particles as well as sudden electrical discharge with the associated risks of fire or explosion.

Guards can need to be earthed to avoid build up of static charge to a hazardous level (see EN 60204-1).

5.14 Thermal stability

Materials shall be selected which do not degrade, e.g. are not subject to brittle fracture, deform excessively or emit toxic or flammable fumes when exposed to the range of foreseeable temperature variations, or sudden changes in temperatures.

Materials selected shall retain their properties in foreseeable climatic and workplace conditions.

5.15 Flammability

Where there is a foreseeable risk of fire, materials selected shall be spark resistant and fire retardant and shall not absorb or emit flammable fluid, fumes, etc.

5.16 Noise and vibration reduction

Where necessary, materials shall be selected to provide noise and vibration reduction. This can be achieved by means of insulation (putting an acoustic barrier in the path of the noise), and/or absorption (lining guards with appropriate acoustically absorbent materials) or a combination of both. Guard panels can also need to be suitably damped to minimise effects of resonance which can transmit or amplify noise (⟨A1⟩ reference: see Bibliography ⟨A1⟩).

5.17 Radiation protection

In certain applications such as welding or use of lasers, materials shall be selected that protect persons from harmful radiation.

For welding applications this can be by means of a suitably tinted transparent screen which permits viewing but eliminates harmful radiation (⟨A1⟩ reference: see Bibliography ⟨A1⟩ and IEC Standard on laser protection).

6 Selection of types of guards

6.1 General

Following risk assessment if a requirement for guards has been established these shall be selected in accordance with the following guidance, and Annex A [A1] (see also EN ISO 12100-2:2003, 5.2) [A1].

In selecting suitable guards the appropriate phases of the life of the machinery [A1] (as indicated in EN ISO 12100-2:2003, 5.3) [A1] shall be considered.

The most important selection criteria are:

— The probability and foreseeable severity of any injury as indicated by the risk assessment;

— The intended use of the machine as defined in [A1] EN ISO 12100-1:2003, 3.22 [A1];

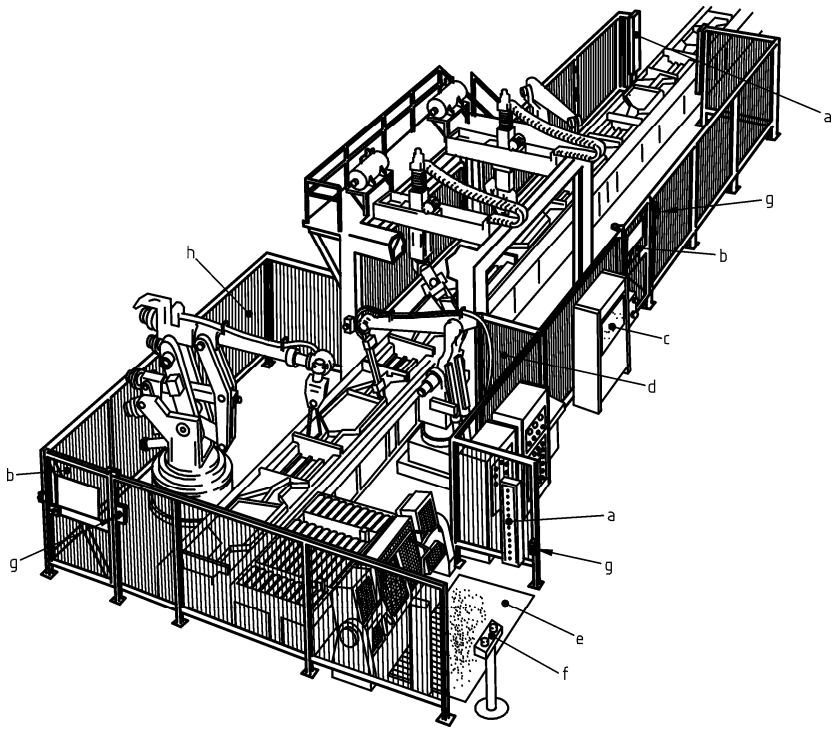
— The hazards present at the machine [A1] (see EN ISO 12100-1:2003, Clause 4 and Clause 5 of this standard) [A1];

— The nature and frequency of access.

6.2 Combination of different guards or of guards with other devices

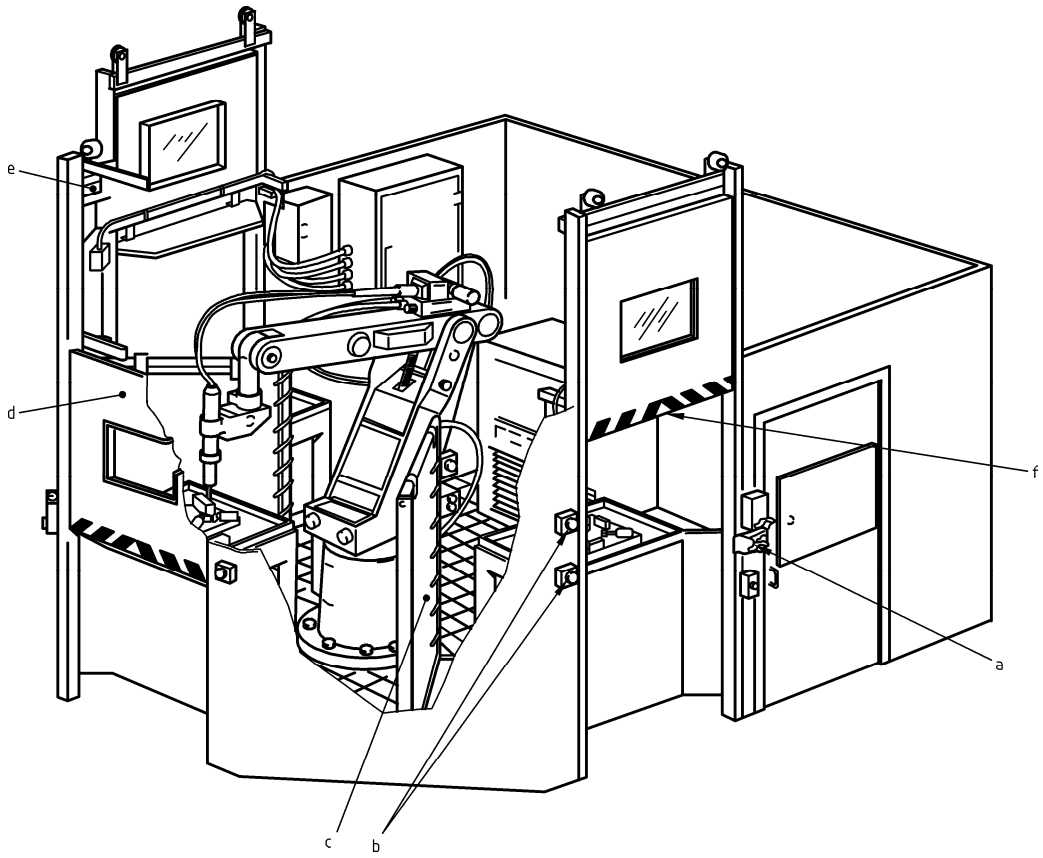
It can be appropriate to use a combination of different types of guard. For example, if a machine has several danger zones and access is required to one of them during the operating phase, the guards can consist of a fixed guard combined with an interlocking movable guard.

In a similar way a combination of protective devices and guards can sometimes be required. For example, where in conjunction with a fixed guard, a mechanical feed device is used to feed workpieces into a machine, (thereby removing the need for access to the danger zone) a trip device [A1] (see EN ISO 12100-1:2003, 3.26.5) [A1] can be required to protect against a secondary trapping or shearing hazard between the mechanical feed device and the fixed guard (see figures 9 and 10).



a) Photo-electric curtain
b) Interlocking guard
c) Electrical cabinet
d) Internal fence allowing only sectional access
e) Pressure sensitive mat
f) Two-hand control device
g) Reset actuator
h) Distance guard

Figure 9 — Example 1 of combination of different guards and guards with other protective devices



a) Trapped key system
b) Two-hand control device
c) Screen between stations
d) Interlocking guard
e) Guard locking device
f) Pressure sensitive edge

Figure 10 — Example 2 of combination of different guards and guards with other protective devices

6.3 Selection of guards according to the number and location of the hazards

Guards should be selected from the following in the order of priority given:

a) Local guards enclosing individual danger zones if the number of danger zones to protect is low. This can provide an acceptable residual risk and permits access to non-hazardous machine parts for maintenance, setting, etc.

b) A guard enclosing all the danger zones if the number or size of the danger zones is high. In this case setting and maintenance points should, as far as possible be located outside the guarded area.

c) Partial distance guard if the use of an enclosing guard is impracticable and the number of danger zones to protect is low.

d) Fully surrounding distance guard if the use of an enclosing guard is impracticable and the number or size of the danger zones are high.

The flow chart in Annex B illustrates this procedure.

It can be beneficial to the production process to divide a guarded area into different sections, to enable actions (e.g. checking, adjustment) in one section to be carried out without affecting machine operation in another section. In this case, the guarding for each section shall comply with all the requirements of this standard.

6.4 Selection of guards according to the nature and frequency FOR access required

NOTE General principles for the selection of guards according to the nature and frequency of access are illustrated in Annex A

6.4.1 Moving transmission parts

Guards to protect against hazards generated by moving transmission parts, e.g. pulleys, belts, gears, rack and pinions, shafts, shall be either fixed guards (see figure 1) or movable interlocking guards.

6.4.2 Where access is not required during use

Fixed guards should be used on account of their simplicity and reliability.

6.4.3 Where access is required during use

6.4.3.1 Where access is required only for machine setting, process correction or maintenance

The following types of guard should be used:

a) Movable guard if the foreseeable frequency of access is high (e.g. more than once per shift), or if removal or replacement of a fixed guard would be difficult. Movable guards shall be associated with an interlock or an interlock with guard locking (see EN 1088).

b) Fixed guard only if the foreseeable frequency of access is low, its replacement is easy, and its removal and replacement are carried out under a safe system of work.

6.4.3.2 Where access is required during the working cycle

The following types of guard should be used:

a) Movable guard with interlock or with interlock with guard locking (see EN 1088). If access is required for a very short working cycle it can be preferable to use a power operated movable guard.

b) Control guard where the special conditions are met for use (see 5.4.9).

6.4.3.3 Where due to the nature of the operation, access to the danger zone cannot be totally prohibited

When tools, e.g. saw blades, need to be partially exposed the following guards are appropriate:

a) Self closing guard (see 5.4.6).

b) Adjustable guard ⟦A1⟩ (see 5.4.7) ⟨A1⟧.

7 Additional design and construction considerations

7.1 Climbing

Climbing on guards shall as far as practicable be inhibited by design. Consideration shall be given to this possibility in their construction and the selection of materials and shapes. For example, by eliminating

horizontal structural members and the horizontal component of mesh fabric from the outside surface of the guard, climbing is made more difficult.

7.2 Retained fastenings

When it is foreseen (e.g. maintenance) that the fixed guard will be removed then the fastenings shall remain attached to the guard or to the machinery (see Figure 11).

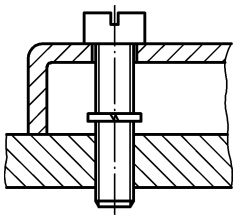


Figure 11 — Example of a retained fastening

7.3 Vibration resistance

Where applicable fastenings can need to be fitted with lock nuts, spring washers etc., to ensure that they remain attached to the guard.

7.4 Warning signs

Where access within the guarded area can expose persons to residual risks, e.g. radiation, appropriate warning signs shall be placed at access points.

7.5 Colour

Hazards can be highlighted by the use of suitable colours. For example if a guard is painted the same colour as the machine and the hazardous parts painted a contrasting bright colour, attention is drawn to the hazard when the guard is opened or left off.

7.6 Aesthetics

As far as practicable, guards shall be designed so as to minimise adverse psychological effects.

8 Verification of the safety requirements for guards

8.1 General

Certain aspects of guard design and construction shall be subject to verification by examination, inspection, testing or calculation. Where practicable, verification shall be carried out with the guard in its working situation.

NOTE For certain machines as specified in the Type-C standards, type testing of the guard is mandatory: in some of these instances this can need to be carried out away from the machine, e.g. power take off guards and guards for abrasive wheels.

8.2 Impact strength

Verification can be required for the resistance of guards to impact from persons, parts of tools, high pressure liquids etc. Before carrying out this verification it is necessary to identify the foreseeable impact hazard to which the guard can be subject, e.g. low velocity impacts from persons, high velocity impacts from broken parts of tools, impact from high pressure fluids.

When verifying the impact strength of a guard, it is necessary to take account of the properties of the materials from which the guard is constructed. This shall include the strength of joints used and the strength of fixing points, slides, etc., by which the guard is attached to the machine or other structure.

Where Type-C standards are available these shall specify the method of verification to be used.

8.3 Safety distances

Verification that guards comply with the required safety distances shall be by measurement ▌A1⟩ (see EN ISO 13857) ⟨A1▌.

8.4 Containment

Where guards are designed for containment of hazardous substances (see 5.1.3) the performance of this function shall be verified. Where leakage is readily seen, visual inspection can be adequate. Where leakage cannot be seen, e.g. leakage of gas or vapour, an alternative verification method such as air sampling is required (see EN 626-1).

8.5 Noise

Where a guard is designed to reduce noise its acoustic performance shall be verified by taking noise readings.

8.6 Guard operating forces

Where normal usage of a guard involves the application of physical force, e.g. to open movable guards, remove fixed guards, it can be necessary to verify that these forces are not excessive as specified by ▌A1⟩ EN 1005-3 ⟨A1▌.

8.7 Visibility

Where the maintenance of visibility through the guard is essential to the proper function of the guard this shall be verified under normal operating conditions by means of a visual check.

9 Information for use

9.1 General

The instructions for use shall contain the required information about guards and their functions, including installation and maintenance ▌A1⟩ (see EN ISO 12100-2:2003, Clause 6) ⟨A1▌.

9.2 Guard hazards

Information shall be provided of any hazards associated with the guards themselves, e.g. flammability of materials.

9.3 Installation

Instructions shall be supplied for the correct installation of guards and associated equipment.

9.4 Operation

Instructions shall be provided directing the user to the correct operation of the guards, their interlocks, etc. Warnings against reasonably foreseeable misuse shall be given [A1] (see EN ISO 12100-2:2003, 3.22 and 3.23) [/A1].

9.5 Removal of guards

Information shall be provided indicating any actions to be taken before guards may be removed safely, e.g. machine power isolation or dissipation of stored energy.

9.6 Inspection and maintenance

Details shall be provided of inspections to be carried out and maintenance required for, e.g.:

— Loss of or damage to any part of the guard, especially when this leads to deterioration of safety performance, e.g. reduction of impact resistance from scratches to glazing materials;

— Replacement of wearing parts;

— Correct operation of interlocks;

— Degradation of jointing or fixing points;

— Degradation by corrosion, temperature change or chemical attack;

— Satisfactory operation and lubrication if necessary of moving parts;

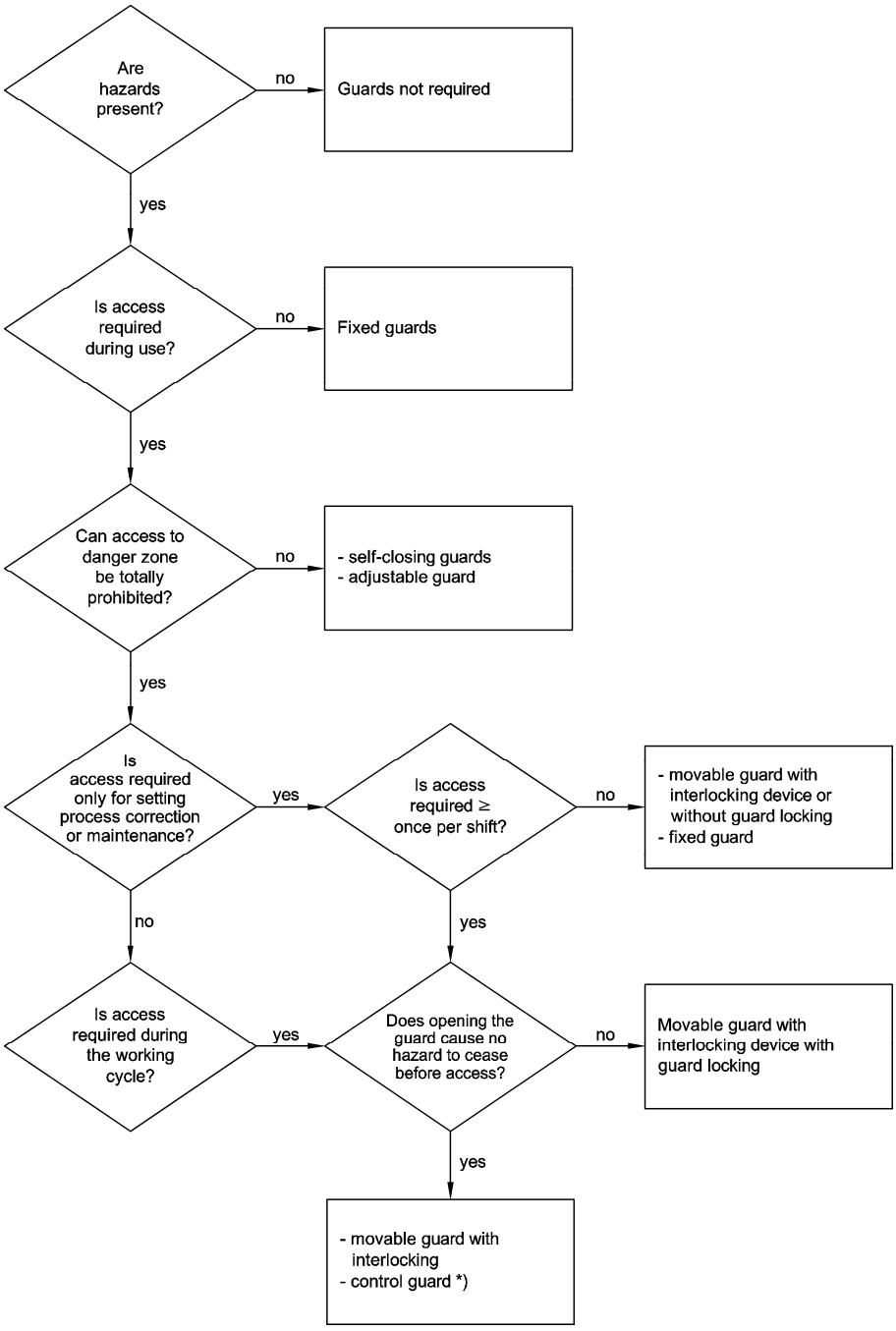
— Modification of safety distances and aperture sizes;

— Degradation of acoustic performance, if applicable.

Annex A
(normative)

Guidelines to assist in the selection of guards against hazards generated by moving parts

This chart shall be used in conjunction with clauses 4 (risk assessment) and 6 (selection of types of guards). This Annex does not take account of the application of other protective devices, two-hand control devices etc.

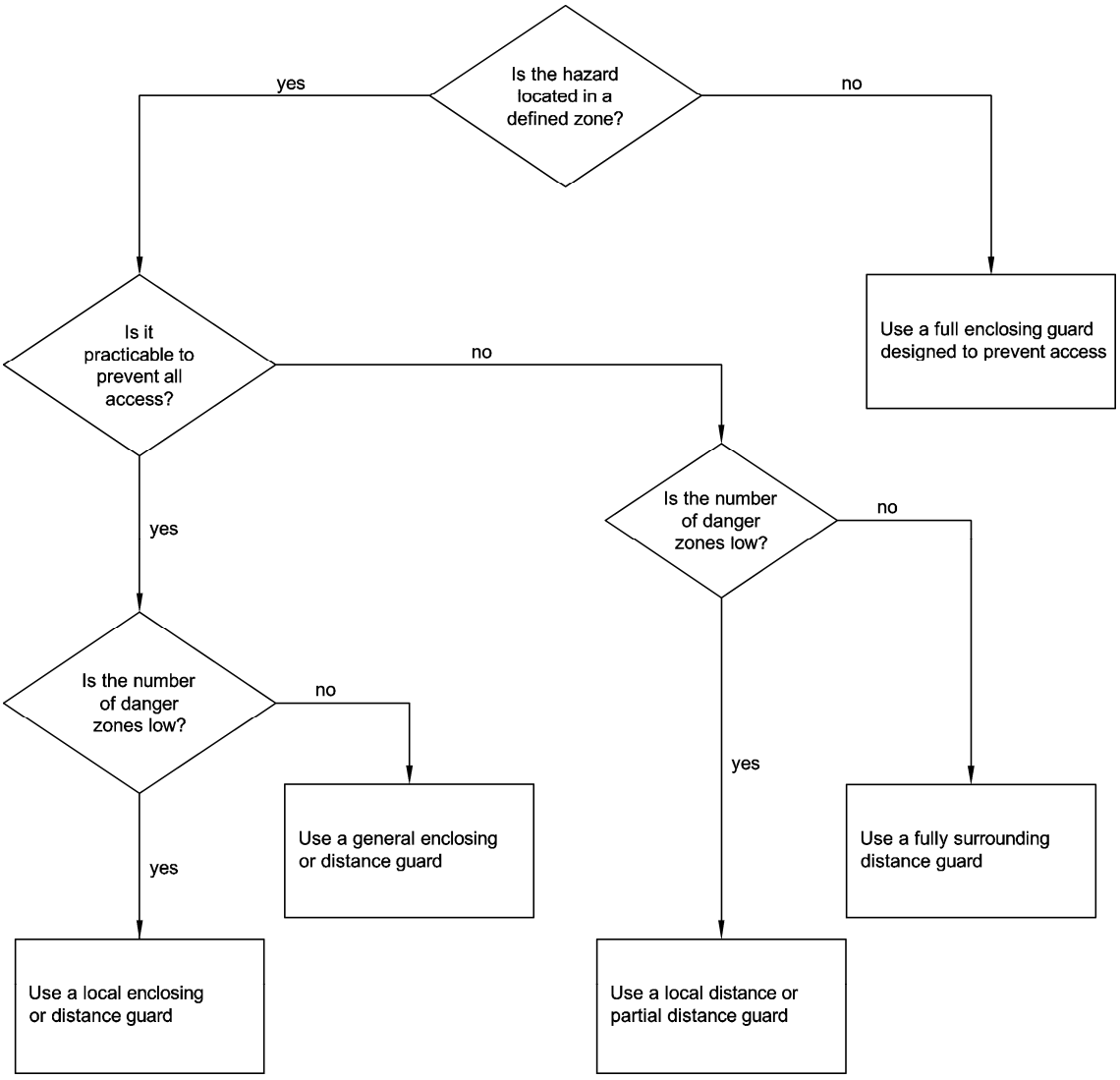


*) The use of control guards is subject to conditions, given in 5.4.9

Annex B
(normative)

Guidelines for the selection of guards according to the number and location of hazards

This chart shall be used in conjunction with Clauses 1 and 4 (risk assessment) and 6.3 (selection of types of guards).



[A1⟩ *deleted text* ⟨A1]

Annex ZA
(informative)

A1 Relationship between this European Standard and the Essential Requirements of EU Directive 98/37/EC

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association to provide a means of conforming to Essential Requirements of the New Approach Directive Machinery 98/37/EC, amended by 98/79/EC.

Once this standard is cited in the Official Journal of the European Communities under that Directive and has been implemented as a national standard in at least one Member State, compliance with the normative clauses of this standard confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding Essential Requirements of that Directive and associated EFTA regulations.

WARNING — Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard. A1

Annex ZB
(informative)

[A1] Relationship between this European Standard and the Essential Requirements of EU Directive 2006/42/EC

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association to provide a means of conforming to Essential Requirements of the New Approach Directive Machinery 2006/42/EC.

Once this standard is cited in the Official Journal of the European Communities under that Directive and has been implemented as a national standard in at least one Member State, compliance with the normative clauses of this standard confers, within the limits of the scope of this standard, a presumption of conformity with the relevant Essential Requirements of that Directive and associated EFTA regulations.

WARNING — Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard. [A1]

〈A1〉 Bibliography

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