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Interested committees:

Title: Draft BS EN ISO 14119 Safety of machinery — Interlocking devices associated with guards — Principles for design and selection.

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	

DRAFT INTERNATIONAL STANDARD

ISO/DIS 14119

ISO/TC 199

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Safety of machinery — Interlocking devices associated with guards — Principles for design and selection

Sécurité des machines — Dispositifs de verrouillage associés à des protecteurs — Principes de conception et de choix

ICS: 13.110

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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.

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

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

This document was prepared by Technical Committee ISO/TC 199, *Safety of machinery*.

This second edition cancels and replaces the first edition (ISO 14119:2013), which has been technically revised.

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

- ISO/TS 19837 “Safety of machinery — Trapped key interlocking devices — Principles for design and selection” is integrated as new normative [Annex L](#) with specific requirements for type 5 interlocking devices - key interlocking devices;
- “Trapped key interlocking systems” are defined as “Type 5 interlocking systems”;
- [Table 4](#) is improved and renamed into “Additional measures in case foreseeable motivation for defeat continues to exist depending on type of interlocking devices”;
- test procedures are described in a new normative [Annex J](#);
- ISO/TR 24119 “Safety of machinery — Evaluation of fault masking serial connection of interlocking devices associated with guards with potential free contacts” integrated in a new normative [Annex K](#).

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

Introduction

The structure of safety standards in the field of machinery is as follows:

- a) Type-A standards (basic safety standards) giving basic concepts, principles for design, and general aspects that can be applied to all machinery;
- b) Type-B standards (generic safety standards) dealing with one safety aspect or one type of safeguard that can be used across a wide range of machinery:
 - Type-B1 standards on particular safety aspects (e.g. safety distances, surface temperature, noise);
 - Type-B2 standards on safeguards (e.g. two-hand controls, interlocking devices, pressure-sensitive devices, guards);
- c) Type-C standards (machine safety standards) dealing with detailed safety requirements for a particular machine or group of machines.

This document is a Type-B2 standard as stated in ISO 12100.

The requirements of this document can be supplemented or modified by a Type-C standard.

For machines which are covered by the scope of a Type-C standard and which have been designed and built according to the requirements of that standard, the requirements of that Type-C standard take precedence.

This International Standard has been prepared to give guidance to machinery designers and writers of product safety standards on how to design and select interlocking devices associated with guards.

Relevant clauses of this International Standard, used alone or in conjunction with provisions from other standards, may be used as a basis for verification procedures for the suitability of a device for interlocking duties.

The informative [Annexes A](#) to [F](#) describe the technology and the typical characteristics of the defined interlocking devices types 1 to 4. Other solutions may be adopted, provided that they comply with the principles of this standard. The informative [Annexes G](#) to [I](#) give information on particular aspects like interlocking devices used within safety functions, risk assessment considering the motivation to defeat and static action forces. The informative [Annex J](#) describes a holding force test and an impact resistance test for guard locking devices. Normative [Annex K](#) provides information on the masking of faults in series connection of interlocking devices. Normative [Annex L](#) provides requirements for type 5 interlocking systems (trapped key interlocking systems) and describes their technology.

Safety of machinery — Interlocking devices associated with guards — Principles for design and selection

1 Scope

This International Standard specifies principles for the design and selection — independent of the nature of the energy source — of interlocking devices associated with guards and provides guidance of measures to minimize the possibility of defeat of interlocking devices in a reasonably foreseeable manner.

This International Standard covers the parts of guards which actuate interlocking devices and principles for the design, selection and application of trapped key interlocking devices and systems for machinery applications, independent of the type of energy used to control them or that they control

NOTE ISO 14120 specifies general requirements for the design and construction of guards provided primarily to protect persons from mechanical hazards. The processing of the signal from the interlocking device to stop the machine and prevent unexpected start up is dealt with in ISO 13849-1 or IEC 62061:2015.

2 Normative references

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

EN 13906-1, *Cylindrical helical springs made from round wire and bar — Calculation and design — Part 1: Compression springs*

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

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

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

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

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

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

IEC 62061:2015, *Safety of machinery — Functional safety of safety-related electrical, electronic and programmable electronic control systems*

3 Terms and definitions

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

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

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

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

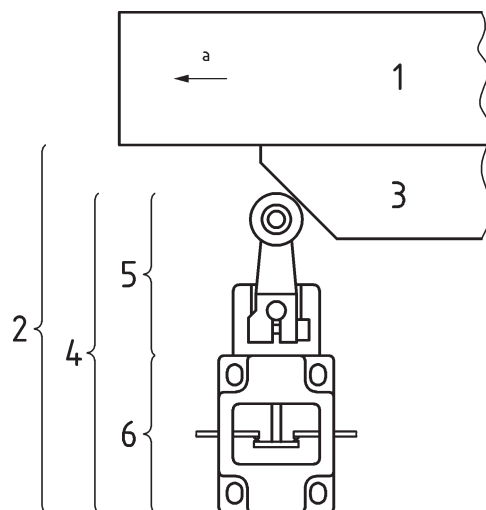
3.1 interlocking device

interlock

mechanical, electrical or other type of device, the purpose of which is to prevent the operation of hazardous machine functions under specified conditions (generally as long as a guard is not closed)

Note 1 to entry: See [Figure 1](#) and [Table 1](#).

[SOURCE: ISO 12100:2010, 3.28.1]



Key

- | | |
|------------------------|--------------------|
| 1 guard | 4 position switch |
| 2 interlocking device | 5 actuating system |
| 3 actuator | 6 output system |
| a Direction of opening | |

Figure 1 — Example of an interlocking device

3.2 interlocking guard

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 associated with 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 associated with by the guard can operate. The closure of the guard does not by itself start the hazardous machine functions.

Note 1 to entry: An interlocking guard can contain/be equipped with one or more interlocking devices. These interlocking devices can also be of different types.

[SOURCE: ISO 12100:2010, 3.27.4]

3.3**interlocking guard with a start function**

control guard

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 1 to entry: ISO 12100:2010, 6.3.3.2.5 gives detailed provisions regarding the condition of use.

[SOURCE: ISO 12100:2010, 3.27.6]

3.4**guard locking device**

device intended to lock a guard in the closed position and linked to the control system

3.5**interlocking guard with locking function**

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 associated with 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 associated with the guard has ceased, and
- when the guard is closed and locked, the hazardous machine functions associated with the guard can operate (the closure and locking of the guard do not by themselves start the hazardous machine functions)

[SOURCE: ISO 12100:2010, 3.27.5]

3.6**safety-related part of a control system****SRP/CS**

part of a control system that performs a safety function, starting from safety-related input(s) to generate safety-related output(s)

Note 1 to entry: The combined safety-related parts of a control system start at the point where the safety-related input signals are initiated (including e.g. the actuating cam and the roller of the position switch) and end at the output of the power control elements (including, for example, the main contacts of a contactor).

Note 2 to entry: If monitoring systems are used for diagnostics, they are also considered as SRP/CS.

[SOURCE: ISO 13849-1:2015, 3.1.1]

3.7**Defeat**

defeat in a reasonably foreseeable manner

reasonably foreseeable action, either manually or by using readily available objects, that makes interlocking devices inoperative or bypasses them with the result that a machine is used in a manner not intended by the designer or without the necessary protective measures

Note 1 to entry: This definition includes the removal of position switches or actuators using tools that are needed for the intended use of the machine or that are readily available (screw drivers, wrenches, hexagon keys, pliers).

Note 2 to entry: Readily available objects for substitute actuation include:

- screws, needles and sheet-metal pieces,
- objects in daily use such as keys, coins, adhesive tape, string and wire,

Note 3 to entry: Uncontrolled spare and master keys for type 5 interlocking devices (see also L 4.2) and spare actuators (for all types) are also considered as readily available objects.

3.8

automatic monitoring

diagnostic function which initiates a fault reaction function if the ability of a component or an element to perform its function is diminished, or if the process conditions are changed in such a way that hazards are generated

3.9

direct mechanical action

positive mechanical action

movement of a mechanical component which arises inevitably from the movement of another mechanical component either by direct contact or via rigid elements

3.10

direct opening action

positive opening operation

<contact element>achievement of contact separation as a direct result of a specified movement of the switch actuator through non-resilient members (for example not dependent upon springs)

[SOURCE: IEC 60947-5-1:2016 + COR1:2016, K 2.2.]

3.11

actuator

separate part of an interlocking device which transmits the state of the guard (closed or not closed) to the actuating system

EXAMPLE Guard-mounted cam, shaped tongue, reflector, magnet, RFID tag.

Note 1 to entry: See also [Annexes A](#) to [E](#) and [L](#).

Note 2 to entry: For Type 1 interlocking devices the actuator can be a part of the guard itself.

Note 3 to entry: Examples of actuators are shown in [Figure 2](#).

Note 4 to entry: A key as used in a trapped key system is not covered by this definition.

3.12

coded actuator

actuator which is specially designed (e.g. by shape) to actuate a certain position switch

3.12.1

low level coded actuator

coded actuator for which 1 to 9 variations in code are available and the different codes are evaluated by the interlocking device

3.12.2

medium level coded actuator

coded actuator for which 10 to 1 000 variations in code are available and the different codes are evaluated by the interlocking device

3.12.3

high level coded actuator

coded actuator for which more than 1 000 variations are available and the different codes are evaluated by the interlocking device

3.13

actuating system

part of the interlocking device which transmits the position of the actuator or the key and changes the state of the output system

EXAMPLE Examples are roller plunger, cam mechanism, and optical, inductive or capacitive sensor.

Note 1 to entry: Examples of actuating systems are shown in [Figure 2](#).

3.14**output system**

part of the interlocking device that signals the state of the actuator or the key to the control system

EXAMPLE Contact element (electromechanical), semiconductor output, valve.

3.15**type 1 interlocking device**

interlocking device with mechanically actuated position switch with uncoded actuator

EXAMPLE Hinged interlocking devices.

Note 1 to entry: See [Annex A](#) for detailed examples.

3.16**type 2 interlocking device**

interlocking device with mechanically actuated position switch with coded actuator

EXAMPLE Tongue-actuated position switches.

Note 1 to entry: See [Annex B](#) for detailed examples.

3.17**type 3 interlocking device**

interlocking device with non-contact actuated position switch with uncoded actuator

EXAMPLE Proximity switches.

Note 1 to entry: See [Annex C](#) for a detailed example.

3.18**type 4 interlocking device**

interlocking device with non-contact actuated position switch with coded actuator

EXAMPLE RFID tag actuated position switches.

Note 1 to entry: See [Annex D](#) for detailed examples.

3.19**type 5 interlocking system**

Trapped key interlocking system

system fulfilling safety function(s) or part of safety function(s) and comprising of at least two trapped key interlocking devices which work together through the transfer of a key.

Note 1 to entry: See [Annex L](#) for detailed examples.

3.19.1**type 5 interlocking device**

Trapped key interlocking device

device, part of a trapped key interlocking device, which fulfils a function by trapping or releasing one or more keys in a given system

EXAMPLE Door locks, key operated switches, key exchange units.

3.19.2**personnel key**

key which is released from a trapped key interlocking device (typically a access lock used in conjunction with whole body access) and retained by a person to prevent a hazardous situation, e.g. unexpected start-up

3.19.3

key trapped

key which is locked until an external input releases it

EXAMPLE A solenoid or the insertion of an actuator releases the trapped key.

3.19.4

key releasable

key which is not locked and so can be (turned and) removed at any time causing a change of state of the device

EXAMPLE Change of state of the device releases or traps another key or changes contact state.

3.19.5

master key

key which can open multiple locks of different coding

3.19.6

key transfer plan

drawing, scheme or diagram depicting the trapped key interlock system with its individual devices and the sequence(s) in which they are to be operated

3.19.7

bolt lock

trapped key interlocking device that extends a bolt to lock an object

EXAMPLE Disconnecter switches, valves or sliding doors.

Note 1 to entry: Examples of objects locked by bolt lock are disconnecter switches, valves or sliding doors.

3.19.8

access lock

trapped key interlocking device used to lock movable guards

EXAMPLE Access locks can also be used for locking in position of objects other than guards, e.g. isolators, valves or barriers.

3.19.9

timed delay key release

trapped key interlocking device that releases a key after a pre-determined period of time has elapsed

3.19.10

key exchange device

trapped key interlocking device in which the insertion of one or more keys releases one or more keys with a different coding, trapping the inserted keys

3.19.11

trapped key switch

trapped key interlocking device comprising a switch which can only be operated by means of a key

3.19.12

trapped key solenoid-controlled switch

trapped key interlocking device comprising a key operated switch which can be mechanically locked by the operation of a solenoid

3.19.13

trapped key valve lock

trapped key interlocking device used to lock a valve in the open position (locked open), in the closed position (locked closed) or in both positions by different keys (LO/LC)

3.19.14**isolation control**

sub function of a trapped key interlocking system to achieve and maintain a safe state of power or movement

3.19.15**intermediate transfer**

sub function of a trapped key interlocking system that allows the transfer of keys between isolation control and access control, subject to the designated conditions

3.19.16**access control**

sub function of a trapped key interlocking system that controls the access to safeguarded spaces or access to machine operating modes and functions

3.19.17**whole body access**

situation where a person can be completely inside a safeguarded space

Note 1 to entry: The term whole body access is used in other standards to specify the opening size for safe access.

[SOURCE: ISO/WD 11161:2019, 3.x]

3.19.18**safeguarded space**

area or volume enclosing a hazard zone(s) where guards and/or protective devices are intended to protect persons

[SOURCE: ISO WD 11161:2019, 3.x]

3.19.19**switch-disconnector**

switch which, in the open position, satisfies the isolating requirements specified for a disconnector

[SOURCE: (IEC 60947-1:2007 + A1:2010 + A2:2014, 2.2.10)]

3.20**stop command**

signal generated by the interlocking device that causes the hazardous machine function to cease

3.21**overall system stopping performance**

time interval between the stop command given by opening the guard and the termination of the hazardous machine function

[SOURCE: ISO 13855:2010, 3.1.2, modified.]

3.22**access time**

time taken by a person to reach the hazard zone after initiation of the stop command by the interlocking device, as calculated on the basis of an approach speed of the body or part of the body

Note 1 to entry: For the selection of the approach speed and the calculation, see ISO 13855.

3.23**holding force**

force that a guard locking device can withstand without being damaged so that its further use will not be impaired and the guard will not leave the closed position

3.24

prevention of inadvertent locking position

feature of a guard locking device which ensures that the locking elements (e.g. a locking bolt) cannot achieve the locking position when the guard is not closed

3.25

emergency release of guard locking

possibility to release manually without auxiliary means the guard locking from outside the safeguarded space in case of an emergency

Note 1 to entry: The guard locking with emergency release can be necessary for releasing trapped persons or fire-fighting, for example.

3.26

auxiliary release of guard locking

possibility to release manually by means of a tool or a key the guard locking from outside the safeguarded space in case of its failure or absence of power supply

Note 1 to entry: The guard locking with auxiliary release is not suitable for emergency or escape release of guard locking.

3.27

escape release of guard locking

possibility to release manually without auxiliary means the guard locking from inside the safeguarded space to leave the area

3.28

guard locking for protection of a person

application of a guard locking device to protect a person against a hazard

3.29

guard locking for protection of the process

application of a guard locking device to protect the working process from being interrupted

3.30

tool

implement such as a key or wrench designed to open and close a fastener

Note 1 to entry: An improvised implement, such as a coin or a nail file, cannot be considered as a tool.

[SOURCE: ISO 14120:2015, 3.7]

3.31

power interlocking

interlocking which directly interrupts the energy supply to the machine actuators or disconnects moving parts from the machine actuators

Note 1 to entry: Resumption of the energy supply is only possible with the guard in the closed and locked position. "Directly" means that, unlike control interlocking, the control system does not play any intermediate role in the interlocking function.

3.32

control interlocking

function which allows access to hazard zone if the energy supply is interrupted using indirect means

Note 1 to entry: Examples of indirect means can include a combination of relay modules, standstill monitoring devices, PLCs or other control devices/systems.

3.33**safety function**

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

[SOURCE: ISO 12100:2010, 3.30]

3.34**position switch**

part of interlocking device comprising the actuating system and the output system

3.35**fault masking**

unintended resetting of faults or preventing the detection of faults in the SRP/CS by operation of parts of the SRP/CS which do not have faults

3.35.1**series connected devices**

devices with potential free contacts that are connected in series to one logic unit which does the diagnostics

3.35.2**signal evaluation of redundant channels with same polarity**

technique where the logic unit of the safety function evaluates redundant signals which have the same supply voltage

3.35.3**signal evaluation of redundant channels with inverse polarity**

technique where the logic unit of the safety function evaluates redundant signals in which the second channel has the ground polarity

Note 1 to entry: See IEC 60204-1:2016, 9.4.3.1, method a)

3.35.4**signal evaluation of redundant channels with dynamic signals**

technique where the logic unit of the safety function evaluates redundant dynamic signals

Note 1 to entry: Dynamic signals can be generated with test pulses, frequency modulation, etc.

3.35.5**single arrangement**

application of two different contacts of a single interlocking device in the redundant channels of an interlocking circuit for a single guard interlocking

Note 1 to entry: [Figure K.4](#) shows a single arrangement.

3.35.6**redundant arrangement**

application of single contacts of two (redundant) interlocking devices in the redundant channels of an interlocking circuit for a single guard interlocking

Note 1 to entry: [Figure K.1](#) to [Figure K.3](#) show redundant arrangements.

3.36**Cabling****3.36.1****star cabling**

cabling structure where every interlocking device is wired with a single cable to the electric cabinet or enclosure

Note 1 to entry: [Figure K.1](#) shows a star cabling.

3.36.2

branch cabling **trunk cabling**

cabling structure where a single cable from the electric cabinet is wired to the first interlocking device and from this interlocking device to the next, and so on, until the last interlocking devices and the resulting signals are wired the same way back to the electric cabinet

Note 1 to entry: [Figure K.2](#) shows a branch (trunk) cabling.

3.36.3

loop cabling

cabling structure where a single cable from the electric cabinet is wired to the first interlocking device and from this interlocking devices to the next, and so on, until the last interlocking device while the signals return to the electric cabinet in a separate cable

Note 1 to entry: [Figure K.3](#) shows a loop cabling.

3.36.4

protected cabling

cabling which is permanently connected (fixed) and protected against external damage, e.g. by cable ducting, armoring, or within an electrical enclosure according to IEC 60204-1:2016.

3.37

interlock blocking device

mechanical means, capable of either being locked or otherwise secured in a position, used to physically block or hold the actuator of an interlock device to prevent actuating or engaging the interlock device (draft ANSI B11.19 (2019/04) [3.33](#))

Note 1 to entry: This may be a padlock or other lockable device.

3.38

Direct guard monitoring (of the position of the guard)

monitoring of the position of the guard, characterized by the detection of the position of the guard provided by a position switch

3.39

Indirect guard monitoring (of the position of the guard)

monitoring of the position of the guard, characterized by the signaling of the closed position of the guard provided by an actuated key operated switch.

Note 1 to entry: The key required for the operation of the switch is only available after the closing and locking of the guard. This can include intermediate steps (transfers).

3.40

category 3 behaviour

<for the mechanical parts of trapped key systems> no single fault results in a loss of the safety function

Note 1 to entry: Category 3 behaviour is characterized by (see ISO 13849-1:2015, 6.2.6):

- continued performance of the safety function in the presence of a single fault;
- detection of some, but not all, faults;
- possible loss of the safety function due to accumulation of undetected faults.

3.41

category 4 behaviour

<for the mechanical parts of trapped key systems> no accumulation of faults results in a loss of the safety function

Note 1 to entry: Category 4 behaviour is characterized by (see ISO 13849-1:2015, 6.2.7):

- continued performance of the safety function in the presence of a single fault;

- detection of faults in time to prevent the loss of the safety function;
- the accumulation of undetected faults is taken into account;
- the consideration of an accumulation of two faults is sufficient (unless an accumulation of 3 or more faults is foreseeable).

3.1 Symbols and Abbreviations

	Symbol	Function
1		key
2	----	key path
3		key trapped (see XYZ)
4		key releasable (see XYZ)
5		key inserted and removable
6		key removed
7		Actuator <i>locked</i>
8		actuator <i>unlocked</i>
9		actuator removed
10		timed delay function (see XYZ)

NOTE The figures in this document show general function principles without claiming any PL or SIL for the associated safety functions. Therefore the corresponding links between contacts are shown in dashed lines, independently if the contacts used are mechanically linked, mirror, or normal auxiliary contacts.

4 Operating principles and types of interlocking devices associated with guards

4.1 General

Interlocking techniques involve a broad spectrum of technological aspects. Interlocking devices can be classified using a great variety of criteria, e.g. the nature of the link between guard and interlock device (types 1 to 5 devices), or the technological type (electromechanical, pneumatic, electronic, etc.) of the interlock device's output system.

Interlocking devices have a guard position monitoring function that senses whether the guard is closed or not and produce a stop command when the guard is not in the closed position. An interlocking device can also be used in the control of other functions e.g. application of a brake to stop hazardous machine functions before access is possible. Some interlocking devices also have a guard locking function to keep the guard locked while hazardous machine function is present. A guard locking device status monitoring function monitors whether the guard locking device is engaged or released and produces an appropriate output signal (see 4.3.1 a) and b)).

NOTE 1 The guard locking device (see 3.4) can be an integral part of an interlocking device, or a separate unit.

NOTE 2 See also ISO 12100:2010, 6.3.3.1 for additional information on guards.

[Table 1](#) shows the actuation principles and actuators for the defined interlocking device types.

NOTE 3 The five types of interlocking device are not presented in a hierarchical order. The correct application of each type of interlocking device will be dependent on the risk assessment that is made for the specific machine.

In addition, under specific conditions, an interlocking guard can be designed such 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 (control guards).

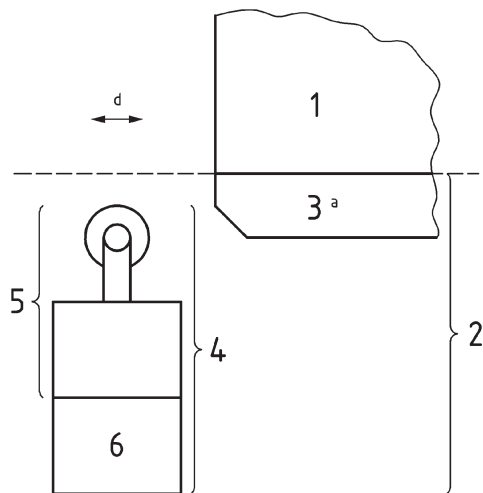
NOTE 4 See ISO 12100:2010 3.27.6. and 6.3.3.2.5 for additional information on control guards)

Table 1 — Overview of interlocking devices

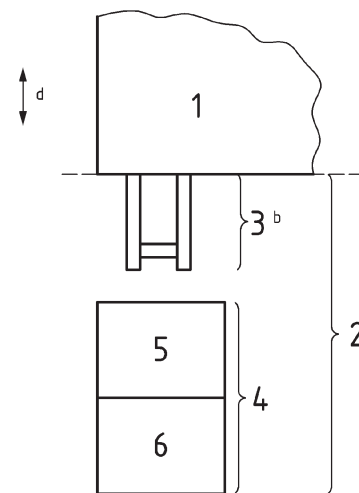
Actuation principle examples		Actuator examples		Guard monitoring	Type	Examples: see Annex ^a
Mechanical	Physical contact/force	Uncoded	Rotary cam	direct	Type 1	A.1
			Linear cam			A.2, A.4
			Hinge			A.3
		Coded	Tongue (-shaped actuator)	direct	Type 2	B.1
Non- contact	Inductive	Uncoded	Suitable ferric metal	direct	Type 3	C
	Magnetic		Magnet, solenoid			
	Capacitive		Any suitable object			
	Ultrasonic		Any suitable object			
	Optic		Any suitable object			
	Magnetic	Coded	Coded magnet	direct	Type 4	D.1
	RFID		Coded RFID tag			D.2
	Optic		Optically coded tag			—
Mechanical (Trapped key)		Coded	shaped	indirect and direct	Type 5	L

^a Examples of other interlocking devices are given in [Annex E](#).

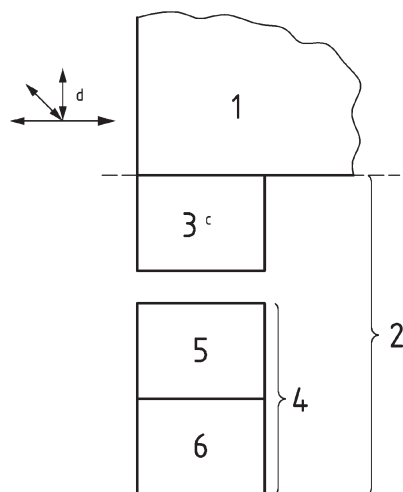
The principle selection criteria for the type of interlocking device is defined by the interlocking function and has precedence over the guard locking function.



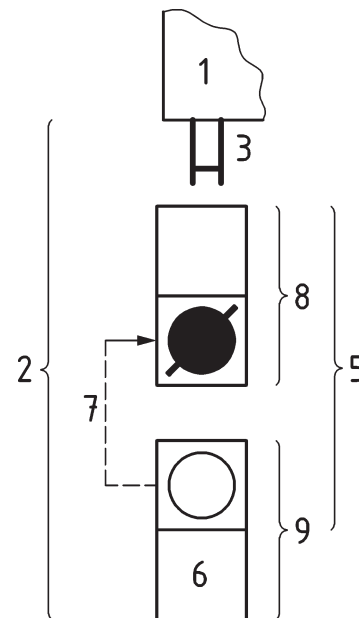
**a) Type 1 interlocking device
(uncoded cam-operated, guard closed)**



**b) Type 2 interlocking device
(coded tongue-operated, guard not closed)**



**c) Type 3 or 4 interlocking device
(uncoded or coded non-contact actuated,
guard closed)**



d) Trapped key interlocking system

Key

- 1 movable guard
- 2 interlocking device/system (Type 5)
- 3 actuator
- 4 position switch
- 5 actuating system
- a Cam
- b Tongue

- 6 output system
- 7 intermediate key transfer
- 8 Type 5 interlocking device (access lock)
- 9 Type 5 interlocking device (trapped key switch)
- c E.g. RFID, reflector, suitable surface
- d Movement direction

NOTE In some exceptional cases, the position switch can be installed on the movable guard and the actuator on the stationary part of the machine. In these cases "1" is the stationary part of the machine.

Figure 2 — Principle of Types 1, 2, 3, 4 and 5 interlocking devices

4.2 Principles of guard interlocking without guard locking

When guard interlocking function without guard locking is used, the guard can be opened at any time regardless of the function of the machine.

If the guard is not closed, the interlocking device shall generate a stop command.

The access time shall be longer than the overall system stopping performance.

NOTE 1 For interlocking with the machine control system see [Clause 8](#).

NOTE 2 Examples of interlocking devices without guard locking are shown in [Annexes A, B, C and D](#).

NOTE 3 A functional diagram of interlocking devices without guard locking is shown in [Figure 3](#).

NOTE 4 See [Clause 9](#) ISO 13855:2010

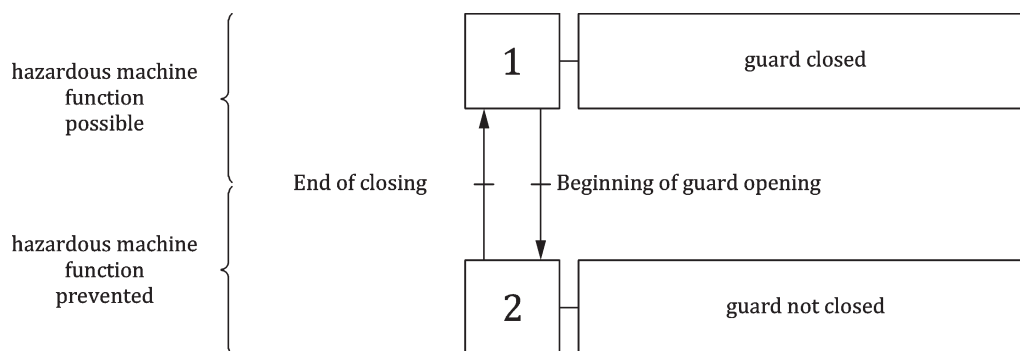


Figure 3 — Functional diagram of interlocking devices without guard locking

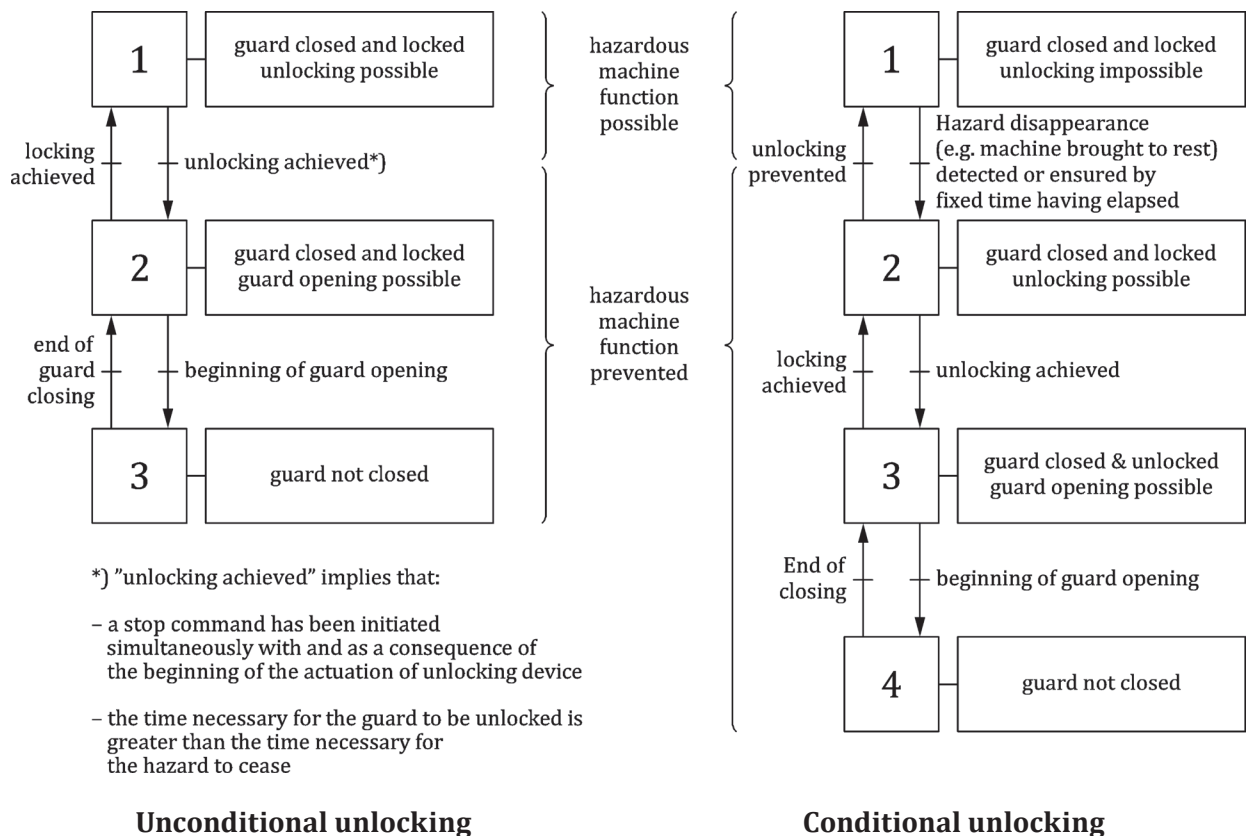
4.3 Principles of guard interlocking with guard locking

4.3.1 General

When interlocking with guard locking is applied, opening of the guard shall be prevented by a guard locking device (see [3.4](#)) unless all hazardous machine functions associated with this guard have ceased.

There are two alternatives for the design of the guard locking function (see [Figure 4](#)).

- Unlocking of the guard can be initiated at any time by the operator. When unlocking is started, the guard locking device generates a stop command. This is called unconditional unlocking. The time necessary for the guard to be unlocked shall be greater than the time necessary for the hazardous machine function to cease.
- Unlocking of the guard is possible only when the hazardous machine functions have ceased or hazardous situation has ceased. This is called conditional unlocking.



NOTE In conditional locking, the change from state 2 to state 3 or from state 3 to state 2 can happen without time delay.

Figure 4 — Functional diagrams of interlocking devices with guard locking

Examples of guard locking devices are given in [Annex F](#).

4.3.2 Interlocking device with mechanically or electromagnetically operated guard locking

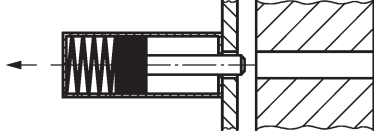
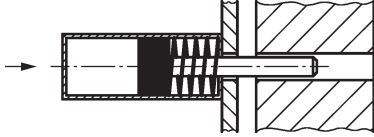
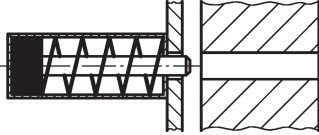
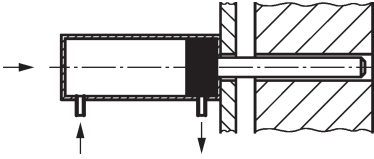
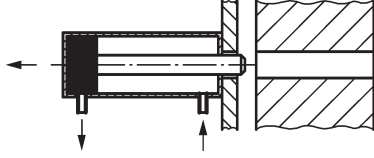
4.3.2.1 The mechanical part (e.g. bolt) which locks the interlocking guard can be

- manually applied and manually released (see [Figure F.5](#));
- spring (or similar) applied and power-ON released [see a) in [Figure 5](#)];
- power-ON applied and spring (or similar) released [see b) in [Figure 5](#)];
- power-ON applied and power-ON released [see c) in [Figure 5](#)].

Mechanically operated guard locking shall use the principle of direct mechanical blocking due to form. Friction and force alone shall not be relied upon.

4.3.2.2 Interlocking device with power-operated guard locking

The guard is kept closed (locked) without any mechanical locking elements by an electromagnetic force (see F.4). The electromagnetic guard locking operates on the principle of power-ON applied and power-OFF released.

a)		Spring applied	Engaged
		Power-ON released	Released
b)		Power-ON applied	Engaged
		Spring released	Released
c)		Power-ON applied	Engaged
		Power-ON released	Released

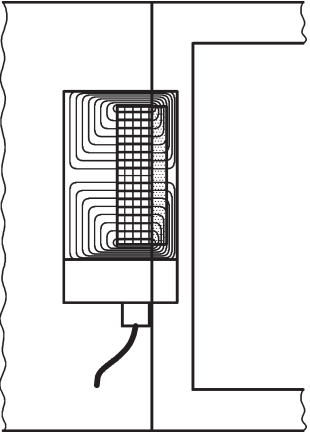
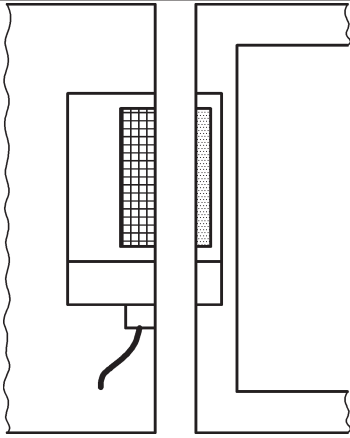
d)		Power-ON applied	Engaged
		Power-OFF released	Released

Figure 5 — Operating modes of guard locking device in power-operated guard locking devices

5 Requirements for the design and the arrangements of interlocking devices with and without guard locking

5.1 General

Interlocking devices shall be installed in accordance with the instructions provided by the manufacturer (see [Clause 9](#)).

5.2 Arrangement and fastening of position switches and bolt locks

Position switches and bolt locks shall be arranged so that they are sufficiently protected against a change of their position. In order to achieve this, the following requirements shall be met:

- fasteners of the position switches and bolt locks shall be reliable and loosening them shall require a tool;
- position switches of type 1 interlocking devices and bolt locks shall have provisions for permanently fixing the location after adjustment (e.g. by means of pins or dowels);
- necessary means of access to position switches and bolt locks for maintenance and checking for correct operation shall be ensured. Prevention of defeat in a reasonably foreseeable manner shall also be considered when designing the access means;
- self-loosening shall be prevented;

- e) the position switch or bolt lock shall be located and, if necessary, protected so that damage from foreseeable external causes is avoided;
- f) the movement produced by mechanical actuation or the gap of the proximity device actuating system shall remain within the specified operating range of the position switch or actuating system specified by the manufacturer of the interlocking device to ensure correct operation and/or prevent overtravel and damaging;
- g) a position switch or bolt lock shall not be used as a mechanical stop, unless this is the intended use of the position switch or bolt lock as declared by the device manufacturer;
- h) misalignment of the guard that creates a gap before the position switch or bolt lock changes its state shall not be sufficient as to impair the protective effect of the guard (for access to hazard zones, see ISO 13855 and ISO 13857);
- i) the support and fastening for the position switches and bolt locks shall be sufficiently rigid to maintain correct operation of the position switch or bolt lock.

5.3 Arrangement and fastening of actuators

5.3.1 General

Actuators (see [Figure 2](#)) shall be so fastened to minimize the possibility that they come loose or change their intended position relative to the actuation system during the intended lifetime.

NOTE A regular check can be necessary (see 9.3.2).

The following requirements shall be met:

- a) fasteners of the actuators shall be reliable and loosening them shall require a tool;
- b) self-loosening shall be prevented;
- c) the actuator shall be located and, if necessary, protected so that damage from foreseeable external causes is avoided;
- d) an actuator shall not be used as a mechanical stop, unless this is the intended use of the actuator as declared by the manufacturer;
- e) the support and fastening for the actuators shall be sufficiently rigid to maintain correct operation of the actuator.

5.3.2 Cams

Rotary and linear cams for Type 1 interlocking devices shall meet the following requirements:

- a) they are fixed by fasteners requiring a tool for loosening them;
- b) final fixing is achieved by form (e.g. spline or pin) or other methods that provide equivalent integrity of fixing;
- c) they do not damage the position switch or impair its durability.

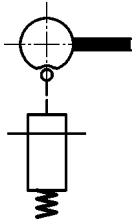
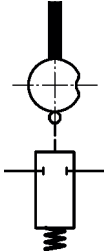
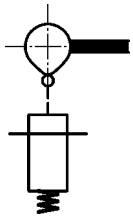
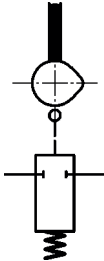
5.4 Actuation modes of Type 1 and Type 2 interlocking devices

When a single Type 1 or Type 2 interlocking device is used to generate a stop command, it shall be actuated by direct mechanical action between guard, actuator and actuating system and the contact element shall have direct opening action (see [3.10](#), [3.11](#) and [Table 2](#)).

Non-direct mechanical action for a Type 1 interlocking device shall be used only in conjunction with a Type 1 or Type 2 interlocking device with direct mechanical action between guard, actuator and output

system. Combining one interlocking device with direct mechanical action with a second interlocking device with non-direct mechanical action avoids common cause failures (see 8.3).

Table 2 — Direct and non-direct mechanical action of Type 1 interlocking devices

Mechanical action	Guard closed	Guard not closed	Working mode	Example of behaviour in case of failure (see 8.3.2)
Direct			Plunger held depressed by cam as long as guard is not closed When guard closed, output system changes its state as result of action of return spring	Output system remains in safe state when guard is not closed even if spring breaks
Non-direct			The plunger is held depressed by a cam as long as the guard is closed. When guard not closed, output system changes state as result of action of return spring.	If spring breaks, output system can go to unsafe state even if guard not closed.

Interlocking devices shall be actuated appropriate to the actuation principle of the applied position switch.

If a Type 3 or Type 4 interlocking device is the only interlocking device it shall meet the requirements of IEC 60947-5-3.

5.5 Mechanical stop

If an interlocking device is declared by the manufacturer of the device to be suitable for use as a mechanical stop the maximum impact energy withstand value shall be given (see also 9.2.2 r)). Maximum impact energy shall be evaluated according to Annex J.2.

5.6 Additional requirements on guard locking devices

5.6.1 General

In addition to the requirements stated in 5.1. to 5.5 the following requirements apply to guard locking devices.

If the application of the guard locking function creates hazards additional measures shall be taken (see 5.6.5 and ISO 12100:2010, 6.3.5.3) e.g. a person exposed to a hazard whilst trapped within a safeguarded space.

The locking element (e.g. bolt) intended to lock the guard shall be "spring applied — power-ON released" (see Figure 5a)) or "power-ON applied — power-ON released" (see Figure 5c) unless the outcome of the risk assessment shows that this is not appropriate. If in a specific application operating modes according to Figure 5 b) or Figure 5 d) are used, measures shall be taken to reduce risks generated by power failures.

NOTE When the loss of power results in the release of the locking element, the stopping time of the machine is often lengthened considerably and it can be possible to access to the hazard before the movements have been stopped (or other hazard not take place).

The electromagnetic coils used for the (un)locking function shall meet the construction and performance requirements of IEC 60947-1:2014, Clause 7.2.2.6.

The requirements of [5.6](#) apply when guard locking function is used for the protection of persons. The requirements do not apply when guard locking function is used solely for the protection of a process. Nevertheless if guard locking function and guard interlocking function are part of the same device the safety level of the guard interlocking function shall not be negatively affected by a non safety related guard locking function (i.e. where the guard locking function is used solely for the protection of the process).

The requirements of [5.6](#) apply to both guard locking devices composed of separate components as well as to guard locking devices which form an integral part of an interlocking device with guard locking. They apply to all technologies.

The guard locking device shall allow the engaged position to be monitored by providing an output system compatible with a control system designed in accordance with ISO 13849-1 or IEC 62061:2015.

The guard locking device shall only allow hazardous functions of the machine when the guard is closed and locked.

5.6.2 Holding Force

The manufacturer of the guard locking device shall ensure that in the engaged position, the guard locking device withstands at least the specified holding force F_{Zh} which shall be determined according to [Annex J](#).

The selection of a guard locking device shall be such that the expected force on the guard (see [Annex I](#)) is less than the holding force F_{Zh} .

5.6.3 Electromechanical guard locking device

5.6.3.1 General

Elektromechanically operating guard locking shall result from the engagement of two rigid parts (form closure, see [Figure 5a](#)) to [Figure 5c](#))).

[Figure 6](#) shows the functionality of such a device.

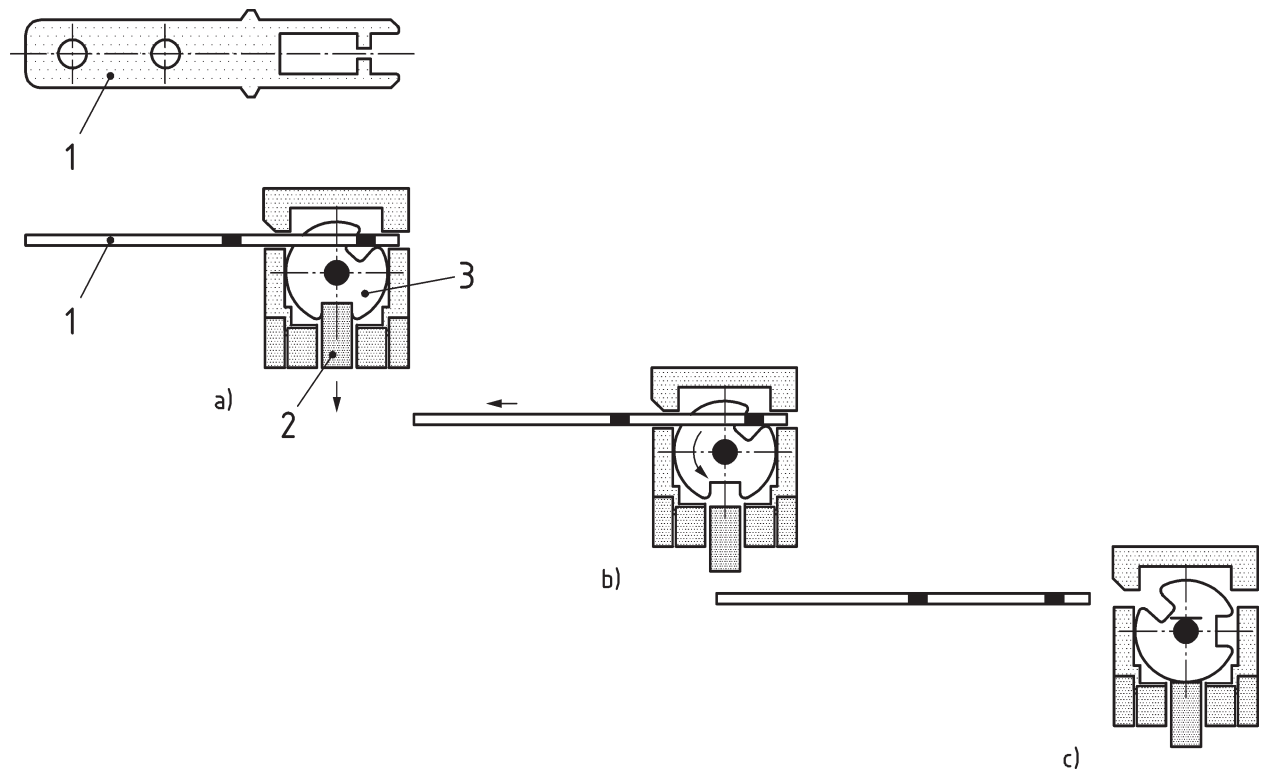
5.6.3.2 Guard locking monitoring

The engaged position of the locking element shall be monitored in accordance with the requirements of [clause 8](#).

The hazardous function of the machine shall only be possible when the monitoring detects the closed position of the guard and the engaged position of the locking element (see [Annex F](#)).

Monitoring of the guard locking device requires one of the following methods to be applied:

- 1) if the locking element can only be engaged when the movable guard is in the closed position (see [Figure 6](#)), by monitoring of the locking element (prevention of inadvertent locking position);
- 2) if 1) does not apply, by monitoring of the locking element and additionally monitoring the guard position.



Key

- | | | | |
|----|---------------------------------|---|--|
| a) | guard closed and locked | 1 | actuator (tongue) |
| b) | guard closed and not locked | 2 | locking element (bolt) |
| c) | guard not closed and not locked | 3 | actuating system (internal rotating cam) |

NOTE In this kind of position switch the actuator has two functions: to operate the contacts (not shown in the figure) and together with the internal rotating cam and the bolt to provide the guard locking function. The bolt can be operated by external means e.g. a solenoid or pneumatic cylinder.

Figure 6 — Prevention of inadvertent locking position

5.6.4 Electromagnetic guard locking device

5.6.4.1 General

The force required for the locking of the guard is applied by the generation of an electromagnetic field (see [Figure 5d](#))).

5.6.4.2 Guardlocking monitoring

The holding force shall be monitored to determine if the specified holding force has been achieved and is maintained.

The hazardous function of the machine shall only be possible when the monitoring detects the closed position of the guard and the achievement of the specified holding force.

5.6.4.3 Basic measures for minimizing defeat possibilities

If an electromagnetic guard locking device is opened by force, it shall be ensured that the process cannot be immediately continued.

NOTE 1 In contrast to a mechanical guard locking, an electromagnetic guard locking shows no damage after an opening by force.

NOTE 2 The objective of the measure is that an opening by force results in a time expenditure which is similar to that of repair works (time delay) and comparable with the repair of a damage of an electromechanical guard locking.

This can be implemented by

- a) means of measures within the guard locking, such as e.g.:
 - 1) a reset after an interruption of the hazardous machine function is only possible after a minimum of 10 min, or
 - 2) the generation of a malfunction of the guard locking, which requires replacement or repair,
- or
- b) means of equivalent time-consuming measures in the machine control system, such as, e.g. the following sequence:
 - 1) warning message at the machine, and
 - 2) cycle stop, and
 - 3) switching-off the production mode, and
 - 4) testing of the guard locking function, and
 - 5) switching-on the production mode, and
 - 6) restarting the next machine cycle (after a fixed time period of a minimum of 10 min).

5.6.5 Trapped key solenoid controlled switch

The principles given for guard locking function, shall apply to the release of the key(s).

5.6.6 Whole body access and supplementary release of guard locking

5.6.6.1 Whole body access

For applications where the risk assessment shows that there is a risk that person(s) can be trapped inside a safeguarded space, measures to prevent this situation shall be implemented.

These measures may include:

- application of personnel keys according to [subclause 5.3](#).
- escape release according to 4.6.6.2
- Use of interlock blocking devices according to 4.7

If there is a risk of unexpected startup of a machine when a person is inside a safeguarded area of the machine, means according to ISO 14118 shall be applied. These measures may include:

- a manual reset function according to ISO 13849-1:2015-5.2.2
- presence sensing devices according to IEC 62046.

Depending on the application, supplementary methods of release of guard locking can be necessary (see ISO 12100:2010, 6.3.5.3). For the selection see [6.2.3](#). Escape and emergency releases of guard locking shall withstand the following:

- expected operating stresses, e.g. force and frequency of operation;
- e.g. influence of abrasive materials e.g. cement dust in a cement production line

- other relevant external influences, e.g. mechanical vibration.

When one of the following supplementary release methods is used, a considerable longer stopping time than normal could be the effect which shall be considered in the risk assessment.

5.6.6.2 Escape release of guard locking

When the guard locking device is provided with an escape release the following requirements shall be met:

- deliberate unlocking of the guard locking from inside of the safeguarded space shall be easily possible without auxiliary means and regardless of the operating condition;
- the unlocking means shall be manually operated and act directly on the principle of the locking mechanism;
- the unlocking shall generate a stop command which is maintained;
- the unlocking means for the escape release shall only be accessible from inside the safeguarded space.

5.6.6.3 Emergency release of guard locking

If it is foreseeable that access is necessary in case of emergency, for "spring applied – power-ON released" or "power-ON applied – power-ON released" systems (see [Figure 5a](#) and [Figure 5c](#)), a guard locking device with emergency release (see 5.6.5.3) shall be provided.

When the guard locking device is provided with an emergency release the following requirements shall be met:

- deliberate unlocking of the guard locking from outside the safeguarded space shall be possible and be easily actuated without auxiliary means, regardless of the operating condition;
- the unlocking means shall be manually operated and act directly on the principle of the locking mechanism;
- the unlocking shall generate a stop command which is maintained;
- the unlocking results in a blocking of the locking means in the released condition;
- the emergency guard locking release shall be clearly marked to be used only in emergency situations and shall be positioned and/or shielded to prevent accidental opening of the lock;
- the resetting of the emergency release shall be possible only by means of a tool or by other methods (e.g. change of component). This requirement can be fulfilled on a control system level. If the requirements are intended to be fulfilled on a control system level (not in the guard locking device), clear instructions that this needs to be achieved shall be provided in the instructions for use of the guard locking device (see [9.2.2 m](#))).

NOTE Provided that the emergency release meets the conditions of an escape release, the emergency release can become an escape release when it is mounted inside of the safeguarded space.

5.6.6.4 Auxiliary release of guard locking

When the guard locking device is provided with an auxiliary release the following requirements shall be met.

- Deliberate unlocking of the guard locking from outside the safeguarded space shall be possible only by the use of a tool or key(s) and regardless of the operating condition. The instructions for use shall state that the restoring of the function of the guard locking device is necessary before normal operation is resumed.
- The unlocking of the auxiliary release shall generate a stop command which is maintained.

- The resetting of the auxiliary release shall be possible only by means of a tool, key(s) or similar objects and by other methods (e.g. change of a component). This requirement can be fulfilled on a control system level. If the requirements are intended to be fulfilled on a safety control system level (not in the guard-locking device), clear instructions that this needs to be achieved shall be provided in the instructions for use of the guard locking device (see [9.2.2](#) m).

5.7 Interlock blocking

For the prevention of an unexpected startup interlock according to ISO 14118:2018, 6.3.3, blocking devices can be provided

Where an interlock blocking device is provided it shall not negatively affect either the interlocking or guard locking function.

The interlock blocking device shall not be used as an insulator means as described in ISO 14118:2018.

The interlock blocking device itself is neither considered as a part of the interlocking device nor of the safety function.

6 Selection of an interlocking device

6.1 General

When selecting an interlocking device for a machine, it is necessary to consider all phases of the machine life cycle.

Selection shall take into account but not be limited to the following criteria:

- the conditions of use and the intended use of the machine (see [6.4](#), ISO 12100:2010, 3.23 and 5.3);
- the hazards present at the machine (see ISO 12100:2010, 5.4);
- the severity of the possible injury (see ISO 12100:2010, 5.5);
- the probability of failure of the interlocking device (see [Clause 8](#));
- overall system stopping performance and access time (see [6.2.1](#));
- the required Performance Level (PLr, see ISO 13849-1:2015) or the required Safety Integrity Level (SIL, see IEC 62061:2015) for the safety functions (see [8.1](#));
- information for use according to [9.2.2](#) provided for the interlocking device(s);
- for Type 4 interlocking devices the means to avoid that a single actuator can be taught in an unlimited manner by the operator without special knowledge and special tools.
- Environmental conditions.

NOTE Type 3, Type 4 and Type 5 (e.g. IP69K according to ISO 20653) interlocking devices can be used to overcome problems arising from the use of Type 1 and Type 2 interlocking devices when a guard can be removed completely from a machine and/or when the environmental/process conditions require a high level of protection (e.g. IP69 according IEC 60529).

6.2 Selection of a guard locking device

6.2.1 Overall system stopping performance and access time

An interlocking device with guard locking shall be used when the overall system stopping performance (see [3.22](#)) is greater than or equal to the access time taken by a person to reach the hazard zone (see [Figure 7](#)).

The access time shall be calculated by using the distance between the hazard zone and the guard together with the approach speed (see ISO 13855 for typical values).

NOTE 1 For the determination of overall systems stopping performance the speed of moving equipment need not be considered under fault conditions (see ISO 13855:2010, Annex D).

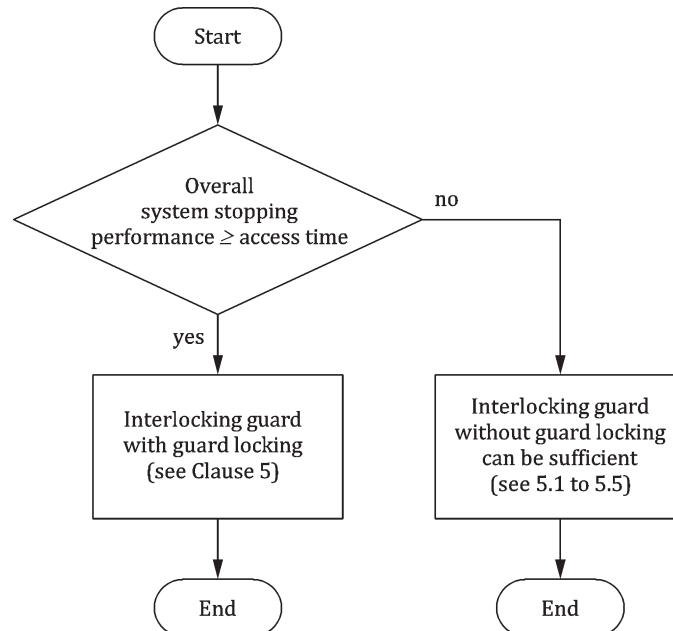


Figure 7 — Determination of the need for guard locking devices

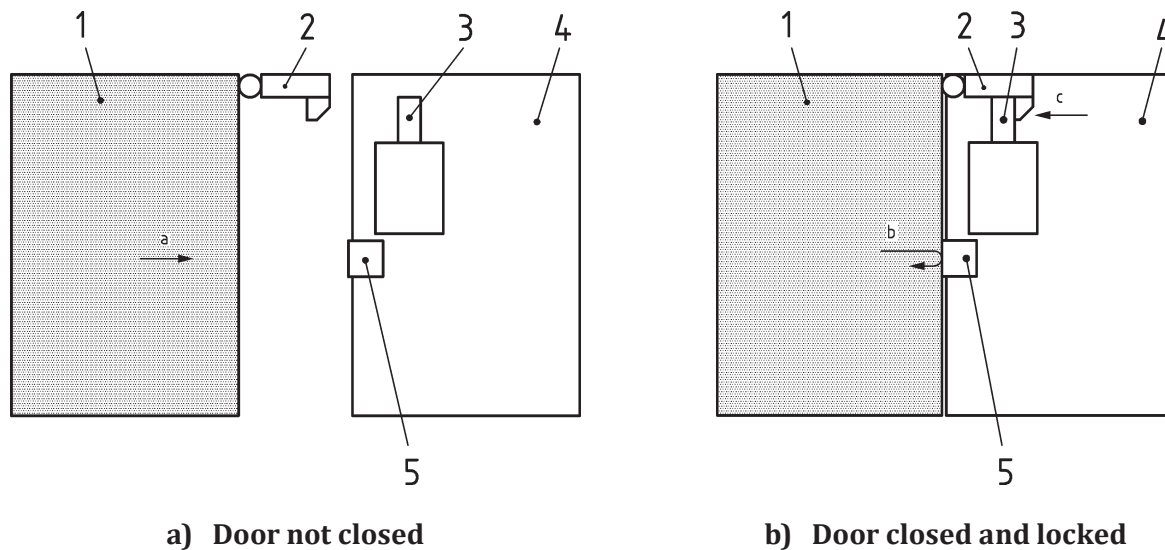
6.2.2 Specific requirements for selection of guard locking devices

The device shall be selected in order to be able to withstand the expected forces. Dynamic effects like bouncing, or chattering shall be considered as well.

If the expected impact reaction forces are higher than the forces the selected device can withstand then design measures shall be applied to reduce or avoid the forces.

NOTE 1 A dynamic force will occur, when the door is being closed and the locking mechanism is already activated, see [Figure 8](#).

When the guard locking device is intended to be activated automatically when the guard reaches the closed position, the selected guard locking device shall withstand the resulting mechanical forces.

**Key**

- | | | | |
|---|--------------------------------|---|---|
| 1 | movable guard | 4 | fixed part of the guard |
| 2 | Actuator | 5 | guard stop |
| 3 | guard locking mechanism (lock) | | |
| a | direction of closing | c | dynamic force expended on locking mechanism |
| b | rebound at guard stop | | |

Figure 8 — Example of a guard locking device affected by dynamic forces

The strength of the mechanical locking elements or the holding force of the electromagnetic locking shall be sufficient to prevent the opening of the guard from the closed position without the help of a crowbar or similar heavy tools.

The holding force needed shall be appropriate to the intended application (see [Annex I](#)).

NOTE 1 It is assumed that the construction of the guard is sufficiently rigid so it does not impair the guard locking function (see ISO 14120)."

NOTE 2 Where a Type C-standard does not specify a specific holding force, the appropriate holding force shall be determined.

NOTE 3 [Annex I](#) gives orientation for the maximum static action forces which can be exerted on movable guards.

Depending on the design, geometry and orientation of the movable guard the exerted maximum static forces can result in a higher value on the guard locking device. Therefore the integrator shall consider the design, geometry and orientation (see [Annex I](#)).

6.2.3 Selection of supplementary guard locking releases

Depending on the application, supplementary methods of release can be necessary. These measures can include but are not limited to:

- an escape release of guard locking according to 5.6.5.2;
- an emergency release of guard locking according to 5.6.5.3;
- special design of the guard to allow escape;
- auxiliary release of guard locking can be necessary when it is foreseen that it is necessary to get to the safeguarded space in special situations, e.g. when the locking is power ON released and the power is lost and the guard locking does not have emergency release function.

NOTE 1 An escape release can be used in combination with an emergency or auxiliary release.

6.3 Controlling Access

Devices for controlling access shall be selected depending on:

- type of access, e.g. whole body access, or part body access, resulting in devices equipped with functions such as e.g. personnel key(s), escape release, emergency release;
- forces expected to work on the devices, defining e.g. the holding force, F_{Zh} ;
- authorization accessing a danger area, e.g. devices incorporating authorization functions;
- additional diagnostic or control functions, e.g. devices incorporating monitoring of the key or actuator position;
- safety concept, e.g. qualification of operators, access during production, frequency and duration of interventions;
- the required safety function, e.g. prevention of unexpected start-up, prevention of restart while a person remains in the safeguarded space.

6.4 Environmental conditions considerations

6.4.1 General

The technology and type of interlocking device shall be considered to ensure that it is suitable for the conditions of use (e. g. environment, hygiene) and for the intended use of the machine.

Environmental conditions shall be considered for the selection of the appropriate interlocking device. Criteria are for example:

- temperature,
- dust,
- moisture,
- vibration and shocks,
- Substances used in the process (e.g. processed materials, cleaning agents),
- electromagnetic influences.

The interlocking device shall withstand all foreseeable influences during its intended lifetime.

Failure can be induced by corrosion from salts, acids or alkalis (e.g. seawater) and the possibility of such effects, particularly over time, shall be taken into account. The particular design of the interlock and type of technology used can cause it to be susceptible to the ingress of chemicals or particles. In areas where significant pollution is present, manufacturer's guidance should be sought.

When combining Type 3 or Type 4 interlocking devices using reed contacts together with monitoring logic units, it shall be verified that possible current spikes caused by the monitoring logic unit are not exceeding the admissible limits of the reed contacts.

6.4.2 Influence of dust on Type 2 and Type 5 interlocking devices

If Type 2 or Type 5 interlocking devices are applied, the possible pollution at the mounting location shall be considered. Type 2 or Type 5 interlocking devices can be unsuitable in applications where the

ingress of particles, chips or dusts cannot be prevented unless suitable measures (e.g. dust protection cover) are applied.

NOTE The actuator is inserted into the position switch, therefore the position switch has an opening which allows the ingress of dust. The indicated degree of protection IPXX according IEC 60529 relates exclusively to the electrical enclosure. The pollution of the mechanical parts can result in the degradation of the mechanism and in a dangerous failure of the interlocking device.

6.5 Considerations for the application of Type 5 devices

A key transfer plan shall be designed for each trapped key interlock system. This transfer plan shall detail the system operation. Key coding shall be established based on the safety related specifications

A Type 5 device may be operated by two or more differently coded keys or a key may operate two or more differently coded Type 5 devices.

NOTE This can be used for a variety of purposes including for example, simplification of an interlocking system.

7 Design to minimize the motivation to defeat interlocking devices

7.1 System design

Interlocking devices shall be designed such that they cannot be easily defeated.

The interlocking device shall provide the minimum possible interference with activities during operation and other phases of machine life, in order to reduce any incentive to defeat it:

- easy operation of the machine, in particular during maintenance and service operations;
- failure-free operation of functionality of a machine.

7.2 Methodology procedure

The interlocking devices shall be selected and/or installed such that defeating in a reasonably foreseeable manner is prevented.

The following procedure shall be followed:

- 1) Implement the basic measures described in [5.2](#), [5.3](#), [5.4](#), 5.6.3.3 and [6.2.2](#).

Type 3 interlocking devices shall not be used unless it is shown by risk assessment that in the application the device cannot be defeated in a reasonably foreseeable manner.

- 2) Check whether the motivation to defeat the interlocking devices in reasonably foreseeable manner exists.

NOTE 1 Considering experience of use of similar machines is helpful, see ISO 12100:2010, 5.2 c).

NOTE 2 [Table H.1](#) in [Annex H](#) can be used for guidance to evaluate and/or eliminate the motivation to defeat interlocking devices.

- 3) Check whether the motivation can be eliminated or minimized by:

- design measures and/or
- appropriate operating modes.

The implementation of appropriate operating modes shall have precedence.

NOTE 3 The implementation of appropriate operating modes can avoid the motivation to defeat. Appropriate operation modes can be, e.g. special modes for setting, tool changing, fault finding, maintenance or process observation. They depend highly on the type of machine and its application and cannot be dealt comprehensively in this standard.

NOTE 4 see ISO 12100:2010, 6.2.11.10

- 4) If foreseeable motivation for defeat continues to exist, additional measures are required (see 7.3).

Figure 9 provides a schematic representation of the methodology for determining the possible incentive and the required measures done by the machine manufacturer.

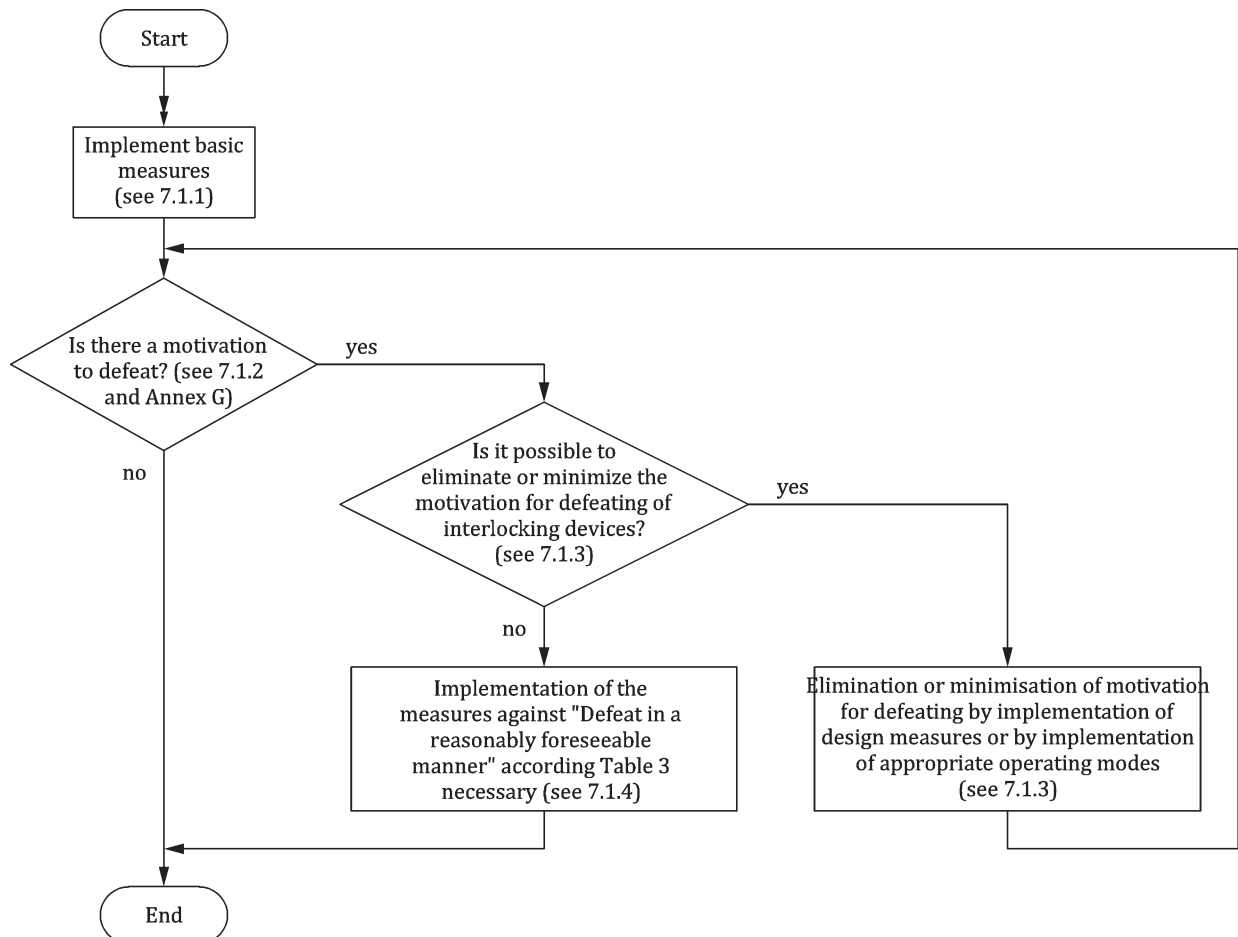


Figure 9 — Methodology for determining the possible incentive to defeat interlocking devices and the required measures done by the machine manufacturer Additional measures to minimize defeat possibilities of interlocking devices

7.3 Additional measures to minimize possibility of defeat

In the following, possible measures against defeat in a reasonably foreseeable manner are mentioned. For the requirements and applicability see Table 4.

- a) Restrict access to the elements of the interlocking device

NOTE The term restriction is used to express a certain physical hindrance but not to restrict the access to a certain group of persons.

- 1) mounting out of reach (see Figure 11),
- 2) physical obstruction or shielding (see Figure 10),