भारतीय मानक

Indian Standard

IS 17277 (Part 4) : 2023
ISO 16092-4 : 2019

मशीनी औजार की सुरक्षा — दाबयंत्र

भाग 4 वातिल दाबयंत्रों के लिए सुरक्षा अपेक्षाएँ

Machine Tools Safety — Presses

Part 4 Safety Requirements for Pneumatic Presses

ICS 25.080.01

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Metal Forming Machines Sectional Committee, PGD 04

NATIONAL FOREWORD

This Indian Standard (Part 4) which is identical with ISO 16092-4 : 2019 'Machine tools safety — Presses — Part 4: Safety requirements for pneumatic presses', issued by the International Organization for Standardization (ISO) was adopted by the Bureau of Indian Standards on the recommendation of the Metal Forming Machines Sectional Committee and approval of the Production and General Engineering Division Council.

This standard specifies the technical safety requirements and measures to be adopted by persons undertaking the design, manufacture and supply of pneumatic presses which are intended to work cold metal or materials partly of cold metal. This standard deals with all significant hazards relevant for pneumatic presses, when they are used as intended and under the conditions of misuse which are reasonably foreseeable by the manufacturer.

This standard has been published in 4 parts. Other parts in this series are:

Part 1 General safety requirements
Part 2 Safety requirement for mechanical presses
Part 3 Safety requirements for hydraulic presses

The text of ISO Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard; and
b) Comma (,) has been used as a decimal marker while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appears to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards, which are to be substituted in their respective places, are listed below along with their degree of equivalence for the editions indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
ISO 4413 : 2010 Hydraulic fluid power — General rules and safety requirements for systems and their components	IS 10481 : 2020/ISO 4413 : 2010 Hydraulic fluid power — General rules and safety requirements for systems and their components	Identical
ISO 12100 : 2010 Safety of machinery — General principles for design — Risk assessment and risk reduction	IS 16819 : 2018/ISO 12100 : 2010 Safety of machinery — General principles for design — Risk assessment and risk reduction	Identical
ISO 13849-1 : 2015 Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design	IS 16810 (Part 1) : 2018/ ISO 13849-1 : 2015 Safety of machinery — Safety related parts of control systems: Part 1 General principles for design	Identical

(*Continued on third cover*)

Contents

Page

Introduction

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

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

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

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

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

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

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

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

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

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

The machinery concerned and the extent to which hazards, hazardous situations or hazardous events are covered are indicated in the Scope of this document.

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

Indian Standard

MACHINE TOOLS SAFETY — PRESSES

PART 4 SAFETY REQUIREMENTS FOR PNEUMATIC PRESSES

1 Scope

This document, in addition to ISO 16092-1, specifies the technical safety requirements and measures to be adopted by persons undertaking the design, manufacture and supply of pneumatic presses which are intended to work cold metal or material partly of cold metal.

This document deals with all significant hazards relevant for pneumatic presses, when they are used as intended and under the conditions of misuse which are reasonably foreseeable by the manufacturer (see Clause 4). All the phases of the lifetime of the machinery as described in ISO 12100:2010, 5.4, have been taken into consideration.

2 Normative references

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

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

ISO 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 16092-1:2017, *Machine tools safety — Presses — Part 1: General safety requirements*

ISO 13851:2019, *Safety of machinery — Two-hand control devices — Functional aspects and design principles*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12100:2010, ISO 13849-1:2015, ISO 16092-1:2017 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
restraint valve
device which protects against a gravity fall of the slide/ram

3.2
overall closing time
time interval from the initiation of a slide movement at TDC to the termination of the movement (the closing of tools) at BDC

4 List of significant hazards

This clause contains all the significant hazards, hazardous situations and events identified by risk assessment as significant for the machines defined in the scope and which require a specific action to eliminate or reduce the risk.

These hazards are listed in ISO 16092-1:2017, Annex A. Additional hazards are listed in Table A.1.

5 Safety requirements and/or measures

5.1 General

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

5.2 Basic design considerations

5.2.1 Hydraulic and pneumatic systems — Common features

ISO 16092-1:2017, 5.2.1, shall apply.

5.2.2 Pneumatic systems

ISO 16092 1:2017, 5.2.2, shall apply.

5.2.3 Hydraulic systems

In addition to the requirements given in ISO 16092-1:2017, 5.2.3, the following shall apply.

Where a pneumatic press is fitted with a pneumatic/hydraulic intensifier, the general requirements in ISO 4413 shall be followed in designing the hydraulic system.

5.2.4 Electric systems

ISO 16092 1:2017, 5.2.4, shall apply.

5.3 Mechanical hazards in the tools area

5.3.1 Major danger zone

ISO 16092-1:2017, 5.3.1, shall apply.

5.3.2 Safeguarding measures

ISO 16092-1:2017, 5.3.2, shall apply

5.3.3 Other safety requirements

ISO 16092-1:2017, 5.3.3, shall apply.

5.3.4 Release of trapped persons between the tools

ISO 16092-1:2017, 5.3.4, shall apply.

5.3.5 Release of persons trapped inside enclosed areas

ISO 16092-1:2017, 5.3.5, shall apply.

5.3.6 Prevention of gravity fall during maintenance or repair

In addition to the requirements given in ISO 16092-1:2017, 5.3.6, the following shall apply.

On presses with an opening stroke length of more than 500 mm and a depth of table of more than 800 mm, a mechanical restraint device shall be permanently fixed and integrated with the press. It can be manually operated.

If an integrated device, when active, cannot be easily seen from the operator's position, an additional clear indication of the position of the device shall be provided.

5.3.7 Prevention of unintended gravity fall during production (down-stroking press)

5.3.7.1 Measures shall be provided to prevent unintended gravity fall of the slide/ram in the production mode with manual or automatic feed or removal (see Tables 1 and 2). Such a fall can be due to a failure of the pneumatic system, mechanical failure or a failure of the electrical control system.

In this case, the following shall be provided:

— a mechanical restraint device;

— a pneumatic restraint device, as defined in 5.3.7.2; or

— a combination of a single valve pneumatic restraint device and a mechanical restraint device.

The restraint devices shall operate automatically and be effective whenever the tool is stopped and access to the tools is possible for the operator.

5.3.7.2 The restraint device shall consist of one or more of the following measures, provided that they are capable of holding up the slide/ram:

a) return spring;

b) clamping device;

c) two pneumatic restraint valves, one of which is fitted as close as possible to the cylinder outlet, using flanged or welded pipework, capable of holding the slide/ram.

5.4 Control and monitoring system

5.4.1 Control and monitoring functions

5.4.1.1 In addition to the requirements given in ISO 16092-1:2017, 5.4.1, the following control and monitoring functions shall apply.

5.4.1.2 For presses pneumatically controlled with a stroke length equal to or less than 30 mm, and a maximum press force equal to or less than 1 000 N, the two-hand control device shall be fixed at the minimum distance as calculated by Formula (1):

$$t = 3 \times t_{max} \quad (1)$$

where

t is the overall response time;

t_{max} is the maximum overall closing time (see also Annex B).

NOTE The factor 3 is intended to compensate the type of two-hand control device selected.

This subclause applies to presses fitted with two-hand control devices used for normal operation. They shall at least correspond to type IIIB of ISO 13851;

It shall not be possible for the overall closing time to be exceeded by any adjustment.

5.4.1.3 Power interlocking, as defined in ISO 14119:2013, 3.31, may be provided for presses fitted with interlocking guards. The guard interlocking device shall be positively linked with the valve to directly control the flow of fluid to and from the cylinder (see Annex C).

5.4.2 Muting

In addition to the requirements given in ISO 16092-1:2017, 5.4.2, the following shall apply.

The means for setting the start point at which the safeguarding system is muted during the closing stroke shall be:

— a position signal when the tools are closed; and

— a pressure signal or suitable alternative signals which actuate when the machine begins to apply the force.

5.4.3 Selection devices

ISO 16092-1:2017, 5.4.3, shall apply.

5.4.4 Position sensors

ISO 16092-1:2017, 5.4.4, shall apply.

5.4.5 Control devices

ISO 16092-1:2017, 5.4.5, shall apply.

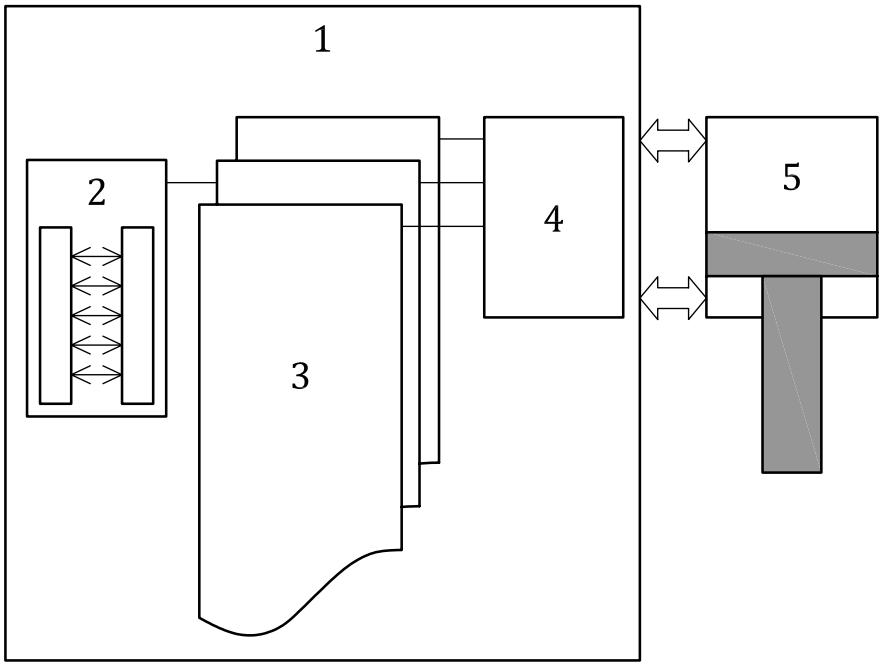
5.4.6 Valves

Manual override devices shall not be directly fitted to restraint valves. If manual override devices are incorporated into other valves for test or maintenance purposes, they shall require the use of a tool to operate the override.

This override shall be of the non-locking type.

5.4.7 Performance level of safety functions

Safety functions of a pneumatic press shall meet the requirements stated in the Tables 1 and 2. Figure 1 shows an example of all relevant parts of a control system of pneumatic press with a safety function to stop any down stroke of the slide by ESPE using AOPD.



Key

1 overall SRP/CS of a safety function "Stop slide down stroke by ESPE using AOPD"
2 "Input": ESPE using AOPD
3 "Logic": control parts (plausibility check of selection, Logic of AOPD, Logic of muting…)
4 output: pneumatic safety-related part
5 pneumatic actuator

Figure 1 — Example of a safety function with all relevant safety-related parts

The performance levels in Tables 1 and 2 are the minimum required performance levels and already take the probability of occurrence into account.

Table 1 — Summary of requirements for the operator safeguarding of the danger zones at the tools, die cushions, work-piece ejectors and transfer systems areas (see ISO 16092-1:2017, 5.3.1) for different modes of operation — Mode of production: Single cycle, manual feed or removal

Main safety system	Hazardous movement	Safety function	Minimum required PL (PL_r) for safety function and I, L and O	Basis for the design of input, logic, output of safety function			
				Requirement for category of Input, Logic and Output[a]	I — Input (sensor area)	L — Logic (control)	O — Output (pre-actuator)
Closed tools used as the only means of protection [see ISO 16092-1:2017, 5.3.2.1 a)]	Movement (e.g. closing stroke) of the slide, die cushions, workpiece ejectors	Cycle initiation/ stop	PL a	Cat B	Any[g]	Any	Pneumatic system (e.g. air valves)
Closed tools used in a press with other operating modes with different main safety systems [see ISO 16092-1:2017, 5.3.2.1 a)]							
Fixed enclosing guard used as the only means of protection [see ISO 16092-1:2017, 5.3.2.1 b)]	Movement (e.g. closing stroke) of the slide, die cushions, workpiece ejectors and transfer systems	Cycle initiation/ stop	PL a	Cat B	Any[g]	Any	Pneumatic system (e.g. air valves)
Interlocking guard with or without guard locking (with or without early opening feature) or control guard (with or without early opening feature) [see ISO 16092-1:2017, 5.3.2.1 c), d) and e)]	Movements (e.g. closing stroke) of the slide and die cushions	Cycle initiation by other control device than the guard	PL a	Cat B	Any but not actuated by the guard itself[g]	Any	Logic control shall act on the appropriate part of the pneumatic or electrical control system

Table 1 *(continued)*

Main safety system	Hazardous movement	Safety function	Minimum required PL (PL_r) for safety function and I, L and O	Basis for the design of input, logic, output of safety function			
				Requirement for category of Input, Logic and Output[a]	I — Input (sensor area)	L — Logic (control)	O — Output (pre-actuator)
Interlocking guard with or without guard locking (with or without early opening feature) or control guard (with or without early opening feature) [see ISO 16092-1:2017, 5.3.2.1 c), d) and e)]	Movements (e.g. closing stroke) of the slide and die cushions	Cycle initiation by control guard	PL a	Cat B	Interlocking device of the guard	Any	Logic control shall act on the appropriate part of the pneumatic or electrical control system
		Stop by interlocking device of guard without guard locking [see ISO 16092-1:2017, 5.3.2.7 and 5.3.2.10 b)]	PL e[b,c]	Cat 4	Interlocking device (2 sensors or equivalent solution)[e,f]	Safety-related logic	Pneumatic system (e.g. air valves)
		Stop by interlocking device of guard with guard locking [see ISO 16092-1:2017, 5.3.2.7 and 5.3.2.10 a)]			Interlocking device with guard locking (2 sensors or equivalent solution)[e,f]		
Interlocking guard with or without guard locking (with or without early opening feature) or control guard (with or without early opening feature) [see ISO 16092-1:2017, 5.3.2.1 c), d) and e)]	Movements (e.g. closing stroke) of the slide and die cushions	Conditional unlocking of guard	PL d	Cat 3 for input and logic, Cat 2[j] for output	Sensor or other suitable detection device to confirm that standstill of slide and die cushion is achieved	Safety-related logic	Pre-actuator of the guard locking
	Movements (e.g. closing stroke) of the slide and die cushions	Muting in case of early opening guard and control guard without guard locking [see ISO 16092-1:2017, 5.4.2]	Same as of the safety function on which muting is acting[q]	—	Position signal or suitable alternative	—	—
Interlocking guard with or without guard locking (with or without early opening feature) or control guard (with or without early opening feature) [see ISO 16092-1:2017, 5.3.2.1 c), d) and e)]	Movements of workpiece ejectors and transfer systems	Stop by interlocking device of guard without guard locking [see ISO 16092-1:2017, 5.3.2.7 and 5.3.2.10 b)]	PL d[b,d]	Cat 3	Interlocking device (2 sensors or equivalent solution)[e,f]	Safety-related logic	Electrical, hydraulic or pneumatic system
		Stop by interlocking device of guard with guard locking [see ISO 16092-1:2017, 5.3.2.7 and 5.3.2.10 a)]	PL d[b,d]	Cat 3	Interlocking device with guard locking (2 sensors or equivalent solution)[e,f]	Safety-related logic	Electrical, hydraulic or pneumatic system

Table 1 *(continued)*

Main safety system	Hazardous movement	Safety function	Minimum required PL (PL_r) for safety function and I, L and O	Basis for the design of input, logic, output of safety function			
				Requirement for category of Input, Logic and Output[a]	I — Input (sensor area)	L — Logic (control)	O — Output (pre-actuator)
Interlocking guard with or without guard locking (with or without early opening feature) or control guard (with or without early opening feature) [see ISO 16092-1:2017, 5.3.2.1 c), d) and e)]	Movements of work-piece ejectors and transfer systems	Conditional unlocking of guard	PL c	Cat 3 for input and logic, Cat 2[j] for output	Sensor or other suitable detection device to confirm that standstill of work-piece ejectors and transfer systems is achieved	Safety-related logic	Pre-actuator of the guard locking
		Muting in case of early opening guard and control guard without guard locking [see ISO 16092-1:2017, 5.4.2]	Same as of the safety function on which muting is acting[q]	—	Position signal or suitable alternative	—	—
Interlocking guard with or without guard locking (with or without early opening feature) or control guard (with or without early opening feature) [see ISO 16092-1:2017, 5.3.2.1 c), d) and e)]	Movements of the slide, die cushions, workpiece ejectors and transfer systems	Prevention of restart by an additional safeguarding of a control guard by AOPD [see ISO 16092-1:2017, 5.3.2.9]	PL e[n]	Cat 4	AOPD	Safety-related logic	Logic control shall act on the appropriate part of the electrical control system
Interlocking guard with or without guard locking (with or without early opening feature) or control guard (with or without early opening feature) [see ISO 16092-1:2017, 5.3.2.1 c), d) and e)]	Movements of the slide, die cushions, workpiece ejectors and transfer systems	Prevention of restart by an additional safeguarding of a control guard by interlocking guard [see ISO 16092-1:2017, 5.3.2.9]	PL c[o,p]	Cat 1 for input, Cat 3 for logic and output	Interlocking device	Safety-related logic	Logic control shall act on the appropriate part of the electrical control system

Table 1 *(continued)*

Main safety system	Hazardous movement	Safety function	Minimum required PL (PL_r) for safety function and I, L and O	Basis for the design of input, logic, output of safety function			
				Requirement for category of Input, Logic and Output[a]	I — Input (sensor area)	L — Logic (control)	O — Output (pre-actuator)
Interlocking guard with or without guard locking [see ISO 16092-1:2017, 5.6.1]	Drive and transmission [see ISO 16092-1:2017, 5.6.1]	Stop by interlocking device of guard without guard locking	PL c	Cat 1	Interlocking device	Safety-related logic	Electric, hydraulic or pneumatic system
		Stop by interlocking device of guard with guard locking					
Interlocking guard with or without guard locking [see ISO 16092-1:2017, 5.6.1]	Drive and transmission [see ISO 16092-1:2017, 5.6.1]	Conditional unlocking of guard	PL c	Cat 1	Sensor or other suitable detection device to confirm that standstill of drive and transmission is achieved	Safety-related logic	Pre-actuator of the guard locking
Interlocking guard opened for tool setting only [see ISO 16092-1:2017, 5.3.2.1 c) and 5.5.6]	Movements of the slide, die cushions, workpiece ejectors and transfer systems	Stop by interlocking device of guard	PL c	Cat 1 for input, Cat 3 for logic and output	Interlocking device	Safety-related logic	Same output than those used for safeguarding measures used in production mode
ESPE using AOPD [see ISO 16092-1:2017 5.3.2.1 f) and 5.3.2.11]	Movements (e.g. closing stroke) of the slide and die cushions	Cycle initiation by other control device than the AOPD	PL a	Cat B	Any but not actuated by the AOPD itself[g]	Any	Logic control shall act on the appropriate part of the electrical control system
ESPE using AOPD [see ISO 16092-1:2017 5.3.2.1 f) and 5.3.2.11]	Movements (e.g. closing stroke) of the slide and die cushions	Cycle initiation by AOPD	PL a	Cat B	AOPD	Any	Logic control shall act on the appropriate part of the electrical control system
ESPE using AOPD [see ISO 16092-1:2017 5.3.2.1 f) and 5.3.2.11]	Movements (e.g. closing stroke) of the slide and die cushions	Stop by AOPD	PL e[c]	Cat 4	AOPD	Safety-related logic	Pneumatic system (e.g. air valves)

Table 1 *(continued)*

Main safety system	Hazardous movement	Safety function	Minimum required PL (PL_r) for safety function and I, L and O	Basis for the design of input, logic, output of safety function			
				Requirement for category of Input, Logic and Output[a]	I — Input (sensor area)	L — Logic (control)	O — Output (pre-actuator)
ESPE using AOPD [see ISO 16092-1:2017, 5.3.2.1 f) and 5.3.2.11]	Movements (e.g. closing stroke) of the slide and die cushions	Muting [see ISO 16092-1:2017, 5.4.2]	Same as of the safety function on which muting is acting[q]	—	Position signal or suitable alternative	—	—
	Movements of workpiece ejectors and transfer systems	Stop by AOPD	PL d[d]	Cat 3	AOPD	Safety-related logic	Electrical, hydraulic or pneumatic system
		Muting [see ISO 16092-1:2017, 5.4.2] Not allowed for transfer system	Same as of the safety function on which muting is acting[q]	—	Position signal or suitable alternative	—	—
	Movements of the slide, die cushions, workpiece ejectors and transfer systems	Prevention of restart by an additional safeguarding by AOPD [see ISO 16092-1:2017, 5.3.2.11 c)]	PL d	Cat 3	AOPD	Safety-related logic	Logic control shall act on the appropriate part of the electrical control system
ESPE using AOPD [see ISO 16092-1:2017, 5.3.2.1 f) and 5.3.2.11]	Movements of the slide, die cushions, workpiece ejectors and transfer systems	Prevention of restart by an additional safeguarding by interlocking guard [see ISO 16092-1:2017, 5.3.2.11 c)]	PL c[o,p]	Cat 1 for input, Cat 3 for logic and output	Interlocking device	Safety-related logic	Logic control shall act on the appropriate part of the electrical control system
Two-hand control device [see ISO 16092-1:2017, 5.3.2.1 g) and 5.3.2.12]	Movements (e.g. closing stroke) of the slide and die cushions	Stop and cycle initiation by two-hand control device	PL e[b,c]	Cat 4	Push buttons of two-hand control device[g,h]	Safety-related logic	Pneumatic system (e.g. air valves)

Table 1 *(continued)*

Main safety system	Hazardous movement	Safety function	Minimum required PL (PL_r) for safety function and I, L and O	Basis for the design of input, logic, output of safety function			
				Requirement for category of Input, Logic and Output[a]	I — Input (sensor area)	L — Logic (control)	O — Output (pre-actuator)
Two-hand control device [see ISO 16092-1:2017, 5.3.2.1 g) and 5.3.2.12]	Movements (e.g. closing stroke) of the slide and die cushions	Stop and cycle initiation for pneumatic presses with a stroke length equal or less than 30 mm and a maximum press force of 1 000 N or less (see 5.4.1.8)	PL d[b,d]	Cat 3	Push buttons of two-hand control device[g,h]	Safety-related logic	Pneumatic system (e.g. air valves)
		Muting (see ISO 16092-1:2017, 5.4.2)	Same as of the safety function on which muting is acting[q]	—	Position signal or suitable alternative	—	—
	Movements of workpiece ejectors and transfer systems	Stop and cycle initiation by two-hand control device	PL d[b,d]	Cat 3	Push buttons of two-hand control device[g,h]	Safety-related logic	Electrical, hydraulic or pneumatic system
Two-hand control device [see ISO 16092-1:2017, 5.3.2.1 g) and 5.3.2.12]	Movements of workpiece ejectors and transfer systems	Muting (see ISO 16092-1:2017, 5.4.2) Not allowed for transfer system	Same as of the safety function on which muting is acting[q]	—	Position signal or suitable alternative	—	—
	Movements of the slide, die cushions, workpiece ejectors and transfer systems	Additional means to restrict access (see ISO 16092-1:2017, 5.3.2.12) Stop by interlocking device of guard	PL d[b,d]	Cat 3	Interlocking device (2 sensors or equivalent solution)	Safety-related logic	Electrical, hydraulic or pneumatic system
		Additional means to restrict access (see ISO 16092-1:2017, 5.3.2.12) Stop by ESPE using AOPD or AOPDDR	PL d[d]		AOPD or AOPDDR		

Table 1 *(continued)*

Main safety system	Hazardous movement	Safety function	Minimum required PL (PL_r) for safety function and I, L and O	Basis for the design of input, logic, output of safety function			
				Requirement for category of Input, Logic and Output[a]	I — Input (sensor area)	L — Logic (control)	O — Output (pre-actuator)
Safety systems which need reset	Movements of the slide, die cushions, workpiece ejectors and transfer systems	Manual reset (see ISO 16092-1:2017, 5.4.1.3)	Same as of the safety function on which it is acting[m]	Any Cat for input[l], Same category as of the selected safety functions for logic and output	Push button	Safety-related logic[l]	Logic control shall act on the appropriate part of the electrical control system
Safety systems which need selection means		Means of selection (see ISO 16092-1:2017, 5.4.3.1)	Same as the highest PLr among the selected functions		Selection means, e.g. selector switch, electronic key system	Safety-related logic to check plausibility of inputs[i]	
Mechanical restraint device	Movements of the slide	Interlocking to the press control system (see 5.3.7)	PL c	Cat 1	Interlocking device	Safety-related logic	Pneumatic system (e.g. air valves)
Emergency stop device	Movement (e.g. closing stroke) of the slide, die cushions, workpiece ejectors and transfer systems	Emergency stop function (see ISO 16092-1:2017, 5.4.1.6, 5.4.5.2 and 5.4.5.3)	PL c	Cat 1	Emergency stop push button[h]	Safety-related logic	Electrical, hydraulic or pneumatic system (e.g. air valves)

[a] In the table, "Requirement for category of Input, Logic and Output" means the following relationships between the requirements of categories for Input, Logic or Output part:

— Cat. 4, 3 or 2 can apply instead of Cat. 1;

— Cat. 4 or 3 can apply instead of Cat. 2;

— Cat. 4 can apply instead of Cat. 3.

Table 1 *(continued)*

Main safety system	Hazardous movement	Safety function	Minimum required PL (PL_r) for safety function and I, L and O	Basis for the design of input, logic, output of safety function			
				Requirement for category of Input, Logic and Output[a]	I — Input (sensor area)	L — Logic (control)	O — Output (pre-actuator)

[b] Fault exclusion (e.g. mechanical break) of a sensor is not acceptable.

[c] Functional safety described in ISO 16092-1:2017, 5.4.1.4 a) to e), shall apply.

[d] Functional safety described in ISO 16092-1:2017, 5.4.1.4 a) to c), and if reasonably practicable ISO 16092-1:2017, 5.4.1.4 d) to e), shall apply.

[e] Plausibility check required or equivalent solution, e.g. 1 system fulfilling the required PL by itself.

[f] See ISO 14119 for the design of interlocking device of guard with guard locking.

[g] In case of mobile control device (e.g. foot pedal) provision shall be made to ensure that unintended start-up due to a short circuit in the cable connecting the control device to the control system is prevented.

[h] In case of mobile control device, provision shall be made to ensure that the stop function remains operational in case of a short circuit in the connecting cable to the control system.

[i] Plausibility check of inputs shall be provided and shall insure that one selected position and the relevant safety measures are still operative without any mal-function or dangerous movements are stopped.

[j] This part can be considered of category 2 if, either demand rate ≤1/100 test rate; or testing occurs immediately upon demand of the safety function and a detected fault leads immediately to a stop of the machine (stop by the output of the testing part of the category 2 system — see NOTE of ISO 13849-1:2015, Figure 10). Restart of the machine shall only be possible after repair.

[k] If required. It depends on the design and structure of the machine.

[l] No specific category is required for input, because logic part will only act after actuation or de-actuation of the input, and any blocking of the input will not lead to any new reset (see ISO 16092-1:2017, 5.4.1.3).

[m] Manual rest function, which is related to a protective device placed where there is no possibility of access of the whole body of a person into the danger zone, may not be subjected to the requirements of PL on this table as a safety function. Only ISO 16092-1:2017, 5.4.1.3 is applied.

[n] F2 is based on the assumption that the additional safeguarding by AOPD is provided to cover the space between the primary protective measure (control guard or ESPE) and the danger zone where a person enters frequently, e.g. at every cycle.

[o] The additional safeguarding by interlocking guard shall not be opened frequently during production (e.g. it is opened only for tool setting, trial or maintenance). Where this is not practicable, other means shall be used.

[p] In the case of additional safeguarding by interlocking guard, P1 is assigned because the guard is in place as a physical obstacle. Even if the interlocking device fails, it is possible that an operator recognizes the guard is removed or opened before initiating a stroke (if additional safeguarding is by AOPD: in case of a failure, an operator can stand undetected between the control guard/primary AOPD and the danger zone).

[q] No specific PL is required for this sub function which shall be considered as an internal part of the safety functions on which it is acting. This internal part shall be taken into account in the evaluation of the PL of the relevant safety functions.

Table 2 — Summary of requirements for the operator safeguarding of the danger zones at the tools, die cushions, work-piece ejectors and transfer systems areas (See ISO 16092-1:2017, 5.3.1) for different modes of operation — Mode of production: Automatic cycle, Solely automatic feed and removal

Main safety system	Hazardous movement	Safety function	Minimum required PL (PL_r) for safety function and I, L and O	Basis for the design of input, logic, output of safety function			
				Requirement for category of Input, Logic and Output[a]	I — Input (sensor area)	L — Logic (control)	O — Output (pre-actuator)
Closed tools used as the only means of protection (see ISO 16092-1:2017, 5.3.2.1 a)	Movement (e.g. closing stroke) of the slide, die cushions, workpiece ejectors	Cycle initiation/ stop	PL a	Cat B	Any[g]	Any	Pneumatic system (e.g. air valves)
Closed tools used in a press with other operating modes with different main safety systems (see ISO 16092-1:2017, 5.3.2.1 a)							
Fixed enclosing guard used as the only means of protection (see ISO 16092-1:2017, 5.3.2.1 b)	Movements of the slide, die cushions, work-piece ejectors and transfer systems	Cycle initiation/ stop	PL a	Cat B	Any[g]	Any	Pneumatic system (e.g. air valves)
Interlocking guard with or without guard locking (see ISO 16092-1:2017, 5.3.2.1 c)	Movements (e.g. closing stroke) of the slide and die cushions	Cycle initiation by other control device than the guard	PL a	Cat B	Any but not actuated by the guard itself[g]	Any	Logic control shall act on the appropriate part of the pneumatic or electrical control system
		Stop by interlocking device of guard without guard locking [see ISO 16092-1:2017, 5.3.2.7 and 5.3.2.10 b)]	PL d[b,d]	Cat 3	Interlocking device (2 sensors or equivalent solution)[e,f]	Safety-related logic	Pneumatic system (e.g. air valves)

Table 2 *(continued)*

Main safety system	Hazardous movement	Safety function	Minimum required PL (PL_r) for safety function and I, L and O	Basis for the design of input, logic, output of safety function			
				Requirement for category of Input, Logic and Output[a]	I — Input (sensor area)	L — Logic (control)	O — Output (pre-actuator)
Interlocking guard with or without guard locking (see ISO 16092-1:2017, 5.3.2.1 c)	Movements (e.g. closing stroke) of the slide and die cushions	Stop by interlocking device of guard with guard locking (see ISO 16092-1:2017, 5.3.2.7 and 5.3.2.10 a)	PL d[b]	Cat 2[j]	Interlocking device with guard locking (2 sensors or equivalent solution)[e,f]	Safety-related logic	Pneumatic system (e.g. air valves)
		Conditional unlocking of guard	PL c	Cat 3 for input and logic, Cat 2[j] for output	Sensor or other suitable detection device to confirm that standstill of slide and die cushion is achieved	Safety-related logic	Pre-actuator of the guard locking
	Movements of work-piece ejectors and transfer systems	Stop by interlocking device of guard without guard locking (see ISO 16092-1:2017, 5.3.2.7 and 5.3.2.10 b)	PL d[b,d]	Cat 3	Interlocking device (2 sensors or equivalent solution)[e,f]	Safety-related logic	Electrical, hydraulic or pneumatic system
Interlocking guard with or without guard locking (see ISO 16092-1:2017, 5.3.2.1 c)	Movements of work-piece ejectors and transfer systems	Stop by interlocking device of guard with guard locking (see ISO 16092-1:2017, 5.3.2.7 and 5.3.2.10 a)	PL d[b]	Cat 2[j]	Interlocking device (2 sensors or equivalent solution)[e,f]	Safety-related logic	Electrical, hydraulic or pneumatic system
Interlocking guard with or without guard locking (see ISO 16092-1:2017, 5.6.1)	Movements of work-piece ejectors and transfer systems	Conditional unlocking of guard	PL c	Cat 3 for input and logic, Cat 2[j] for output	Sensor or other suitable detection device to confirm that standstill of work-piece ejectors and transfer systems is achieved	Safety-related logic	Pre-actuator of the guard locking
Interlocking guard with or without guard locking (see ISO 16092-1:2017, 5.6.1)	Drive and transmission (see ISO 16092-1:2017, 5.6.1)	Stop by interlocking device of guard without guard locking	PL c	Cat 1	Interlocking device (2 sensors or equivalent solution)[e,f]	Safety-related logic	Electric, hydraulic or pneumatic system

Table 2 *(continued)*

Main safety system	Hazardous movement	Safety function	Minimum required PL (PL_r) for safety function and I, L and O	Basis for the design of input, logic, output of safety function			
				Requirement for category of Input, Logic and Output[a]	I — Input (sensor area)	L — Logic (control)	O — Output (pre-actuator)
Interlocking guard with or without guard locking (see ISO 16092-1:2017, 5.6.1)	Drive and transmission (see ISO 16092-1:2017, 5.6.1)	Stop by interlocking device of guard with guard locking	PL c	Cat 1	Interlocking device with guard locking (2 sensors or equivalent solution)[e,f]	Safety-related logic	Electric, hydraulic or pneumatic system
		Conditional unlocking of guard	PL c	Cat 1	Sensor or other suitable detection device to confirm that standstill of drive and transmission is achieved	Safety-related logic	Pre-actuator of the guard locking
Interlocking guard opened for tool setting only (see ISO 16092-1:2017, 5.3.2.1 c and 5.5.6)	Movements of the slide, die cushions, workpiece ejectors and transfer systems	Stop by interlocking device of guard	PL c	Cat 1 for input, Cat 3 for logic and output	Interlocking device	Safety-related logic	Same output than those used for safeguarding measures used in production mode
ESPE using AOPD (see ISO 16092-1:2017 5.3.2.1 f and 5.3.2.11)	Movements (e.g. closing stroke) of the slide and die cushions	Cycle initiation by other control device than the AOPD	PL a	Cat B	Any but not actuated by the AOPD itself[g]	Any	Logic control shall act on the appropriate part of the electrical control system
ESPE using AOPD (see ISO 16092-1:2017, 5.3.2.1 f and 5.3.2.11)	Movements (e.g. closing stroke) of the slide and die cushions	Stop by AOPD	PL d [d]	Cat 3	AOPD	Safety-related logic	Pneumatic system (e.g. air valves)
	Movements of workpiece ejectors and transfer systems						
Common features							
Safety systems which need reset	Movements of the slide, die cushions, workpiece ejectors and transfer systems	Manual reset (see ISO 16092-1:2017, 5.4.1.3)	Same as of the safety function on which it is acting[l]	Any Cat for input[k], Same category as of the selected safety functions for logic and output	Push button	Safety-related logic[k]	Logic control shall act on the appropriate part of the electrical control system

Table 2 *(continued)*

Main safety system	Hazardous movement	Safety function	Minimum required PL (PL_r) for safety function and I, L and O	Basis for the design of input, logic, output of safety function			
				Requirement for category of Input, Logic and Output[a]	I — Input (sensor area)	L — Logic (control)	O — Output (pre-actuator)
Safety systems which need selection means	Movements of the slide, die cushions, workpiece ejectors and transfer systems	Means of selection (see ISO 16092-1:2017, 5.4.3.1)	Same as the highest PLr among the selected functions	Any Cat for input[k], Same category as of the selected safety functions for logic and output	Selection means, e.g. selector switch, electronic key system	Safety-related logic to check plausibility of inputs[i]	Logic control shall act on the appropriate part of the electrical control system
Mechanical restraint device	Movements of the slide	Interlocking to the press control system (see 5.3.7)	PL c	Cat 1	Interlocking device	Safety-related logic	Pneumatic system (e.g. air valves)
Slow speed and hold to run control (See ISO 16092-1:2017, 5.3.3.4)	Movements of handling device	Slow speed	PL c	Cat 2[j]	Encoder or suitable alternative		Electrical, hydraulic or pneumatic system
		Hold to run control			2 electro-mechanical contacts (1 for initiation, 1 for diagnostic)[g,h]		
Inching device	Movements of handling device	Start and automatic stop of a limited stroke	PL c	Cat 1 for Start Input Cat 3 for Logic and Output	Any for start[g]	Safety-related logic utilizing e.g. fault resistant position detection or time depending on machine speed	Electrical, hydraulic or pneumatic system
Emergency stop device	Movement (e.g. closing stroke) of the slide, die cushions, workpiece ejectors and transfer systems	Emergency stop function (see ISO 16092-1:2017, 5.4.1.6, 5.4.5.2 and 5.4.5.3)	PL c	Cat 1	Emergency stop push button[h]	Safety-related logic	Electrical, hydraulic or pneumatic system (e.g. air valves)

[a] In the table, "Requirement for category of Input, Logic and Output" means the following relationships between the requirements of categories for Input, Logic or Output part:

— Cat. 4, 3 or 2 can apply instead of Cat. 1

— Cat. 4 or 3 can apply instead of Cat. 2

— Cat. 4 can apply instead of Cat. 3.

Table 2 *(continued)*

Main safety system	Hazardous movement	Safety function	Minimum required PL (PL_r) for safety function and I, L and O	Basis for the design of input, logic, output of safety function			
				Requirement for category of Input, Logic and Output[a]	I — Input (sensor area)	L — Logic (control)	O — Output (pre-actuator)

[b] Fault exclusion (e.g. mechanical break) of a sensor is not acceptable.

[c] Functional safety described in ISO 16092-1:2017, 5.4.1.4 a) to e), shall apply.

[d] Functional safety described in SO 16092-1:2017, 5.4.1.4 a) to c), and if reasonably practicable ISO 16092-1:2017, 5.4.1.4 d) to e), shall apply.

[e] Plausibility check required or equivalent solution, e.g. 1 system fulfilling the required PL by itself.

[f] See ISO 14119 for the design of interlocking device of guard with guard locking.

[g] In case of mobile control device (e.g. foot pedal) provision shall be made to ensure that unintended start-up due to a short circuit in the cable connecting the control device to the control system is prevented.

[h] In case of mobile control device, provision shall be made to ensure that the stop function remains operational in case of a short circuit in the connecting cable to the control system.

[i] Plausibility check of inputs shall be provided and shall insure that one selected position and the relevant safety measures are still operative without any mal-function or dangerous movements are stopped.

[j] This part can be considered of category 2 if, either demand rate ≤1/100 test rate; or testing occurs immediately upon demand of the safety function and a detected fault leads immediately to a stop of the machine (stop by the output of the testing part of the category 2 system — see NOTE of ISO 13849-1:2015, Figure 10). Restart of the machine shall only be possible after repair.

[k] No specific category is required for input, because logic part will only act after actuation or de-actuation of the input, and any blocking of the input will not lead to any new reset (see ISO 16092-1:2017, 5.4.1.3).

[l] Manual rest function, which is related to a protective device placed where there is no possibility of access of the whole body of a person into the danger zone, may not be subjected to the requirements of PL on this table as a safety function. Only ISO 16092-1:2017, 5.4.1.3 is applied.

5.5 Tool-setting, trial strokes, maintenance and lubrication

In addition to the requirements given in ISO 16092-1: 2017, 5.5, the following shall apply.

Movement during tool-setting, for maintenance and lubrication:

Facilities shall be provided to allow the movement of the slide/ram during tool-setting, maintenance and lubrication to be carried out with guards and protective devices in position and operational (see ISO 16092-1:2017, 5.3.2.1)

Where this is not practicable, at least one of the following facilities shall be provided:

a) a two-hand control device in accordance with ISO 16092-1:2017, 5.5.7. If it is not of type IIIC (or not of type IIIB in accordance with 5.4.1.2), it needs to be arranged so that it cannot be used for production (e.g. by its positioning and distance from the tools area, using slow speed, equal or less than 10 mm/s, limited movement);

b) a hold-to-run control device used in conjunction with slow closing speed (equal to or less than 10 mm/s).

5.6 Mechanical hazards — Other

ISO 16092-1:2017, 5.6, shall apply.

5.7 Slips, trips and falls

ISO 16092-1:2017, 5.7, shall apply.

5.8 Protection against other hazards

ISO 16092-1:2017, 5.8, shall apply.

6 Verification of the safety requirements and/or measures

Table 3 indicates by crosses the method(s) by which the safety requirements and protective measures described in Clause 5 and Annex B. shall be verified, together with a reference to the corresponding subclauses in this document.

Table 3 — Means of verification of the safety requirements and/or measures for type testing

Subclause	Safety requirements and/or measures	Visual inspection[a]	Performance check/test[b]	Measurement[c]	Drawings/ Calculations/ Technical data[d]
5.2	**Basic design considerations**				
5.2.3	**Hydraulic systems**				
5.2.3	Pneumatic/hydraulic intensifier	x	x		x
5.3	**Mechanical hazards in the tools area**				
5.3.6	**Prevention of gravity fall during maintenance or repair**				
5.3.6	Mechanical restraint device	x	x	x	x
5.3.7	Prevention of unintended gravity fall during production (down-stroking press)				
5.3.7.1	Mechanical, pneumatic or combined restraint devices	x	x	x	x

Table 3 *(continued)*

Subclause	Safety requirements and/or measures	Visual inspection[a]	Performance check/test[b]	Measurement[c]	Drawings/ Calculations/ Technical data[d]
5.4	**Control and monitoring system**				
5.4.1	**Control and monitoring functions**				
5.4.1.2	Overall response time		x	x	x
	Stroke length ≤30 mm	x	x	x	x
	Press force 1 000 N		x	x	x
5.4.1.3	Power interlocking	x	x		x
5.4.2	**Muting**				
5.4.2	Position and pressure signal, or suitable alternative signals	x	x		x
5.4.6	**Valves**				
5.4.6	No override on restraint valves	x			x
	Tool need for manual override	x	x		x
	Non-locking type	x	x		x
5.4.7	**Performance of safety functions**				
	Requirements of Tables 1 and 2 are met	x	x	x	x
5.5	**Toolsetting, trial strokes, maintenance, lubrication**				
5.5	Guards and protective devices in position and operational	x	x		x
	or: Two-hand control devices	x	x	x	x
	or: Hold-to-run control device with slow speed	x	x	x	x
7	**Information for use**				
7.4	Instruction handbook	x			x
Annex B	**Minimum (safety) distances**			x	x

[a] Visual inspection is used to verify the features necessary for the requirement by visual examination of the components supplied.

[b] A performance check/test verifies that the features provided perform their function in such a way that the requirement is met.

[c] Measurement verifies by the use of instruments that requirements are met, to the specified limits.

[d] Drawings/calculations/technical data verifies that the design characteristics of the components provided meet the requirements.

7 Information for use

7.1 General

ISO 16092-1:2017, 7.1, shall apply.

7.2 Marking

ISO 16092-1:2017, 7.2, shall apply.

7.3 Warnings

ISO 16092-1:2017, 7.3, shall apply.

7.4 Instruction handbook

In addition to the requirements given in ISO 16092-1:2017, 7.4, the following shall apply.

a) In particular, the instructions for installation shall state that the installer fit pressure switches in the line if air pressure can exceed the maximum air inlet pressure defined by the manufacturer, by more than 10 %.

b) Instructions on how to ensure that the increasing leakage speed of the slide/ram during use does not exceed 5 mm/s. This shall be maintained.

The instruction handbook shall inform the operator that:

— additional means of protection can be necessary to minimize the operator's exposure to hazardous substances that can be processed by the user.

NOTE 1 As these substances are not defined in this clause, the necessary means are not included in the scope of this document.

— additional precautions can be necessary to minimize the risk from fire and explosion depending on the use of the press.

NOTE 2 Where flammable substances are used, EN 1127-1 provides guidance.

Annex A
(informative)

Additional significant hazards, hazardous situations and protective measures

In addition to hazards listed in ISO 16092-1:2017, Annex A, this annex contains the significant hazards, hazardous situations and events identified by risk assessment as significant for this type of machinery and which require action to eliminate or reduce the risk (see Table A.1).

Table A.1 — Additional significant hazards, hazardous situations and protective measures

ISO 12100:2010, Annex B	Origin of hazards	Hazardous situations on presses	Relevant subclause in this document
1 Mechanical hazards			
B.1	Gravity	Production Maintenance and repair	5.3.7 5.3.6
B.1	High pressure Stored energy	All modes of operation and maintenance situations	5.2.3
B.1	Moving elements	Production, Tool setting, trial strokes, maintenance or lubrication	5.4 5.5

Annex B
(normative)

Calculation of minimum distances

When calculating the overall closing time and the overall system stopping performance, the following features shall be taken into account under the severest normal conditions:

a) the maximum stroke length in relation to the overall response time (see ISO 16092-1:2017, D.1);

b) slide/ram speed resulting in the longest stopping time (in case of adjustable speed, maximum and minimum slide/ram speed resulting in the longest stopping time);

c) the maximum tool mass, according to the intended use of the press;

d) the pressure condition resulting in the longest stopping time;

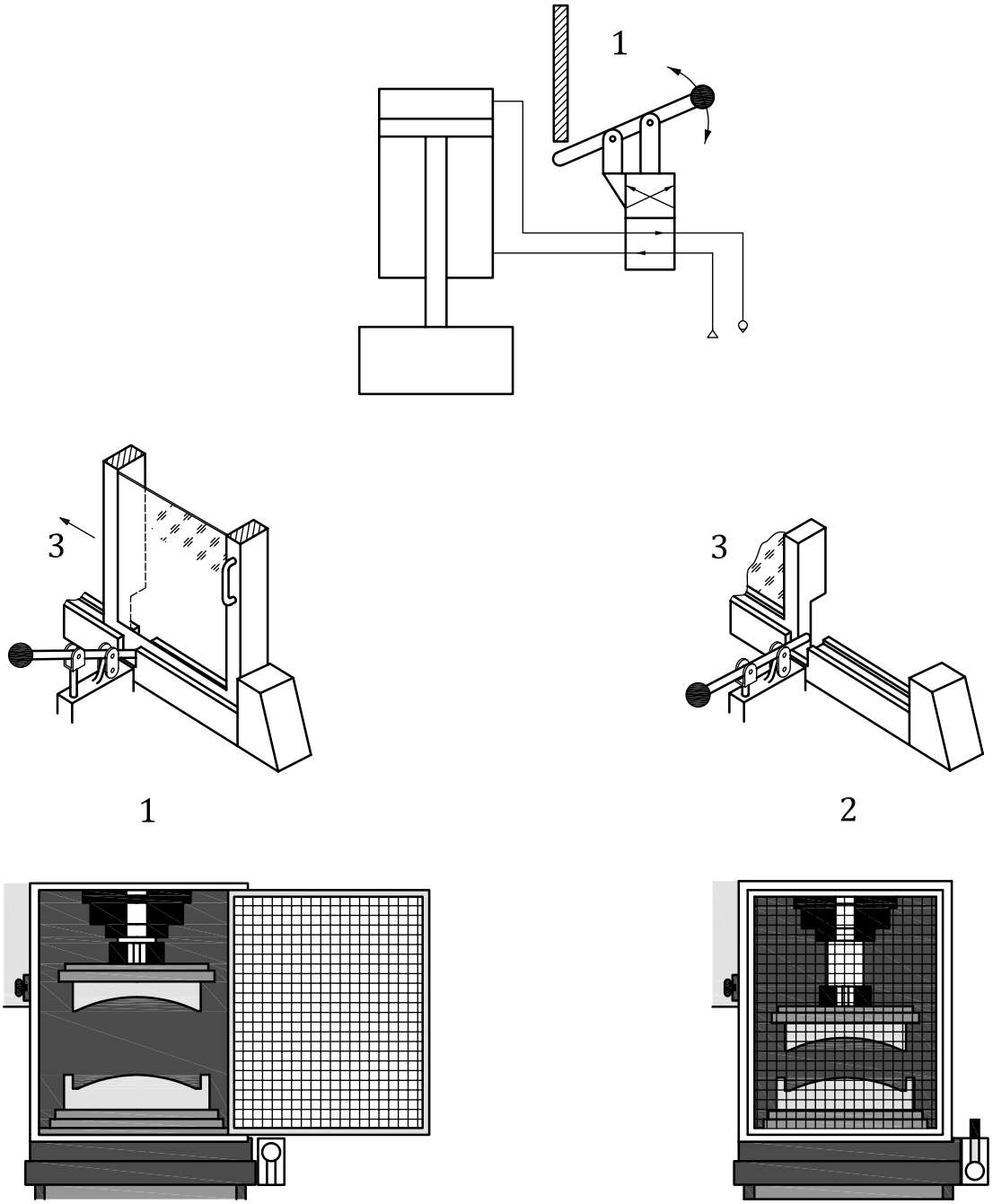
e) apply a safety coefficient of 1,5 to cover the wear of the relevant parts of the stopping function;

f) the effect of any rapid exhaust valve and its silencers.

Annex C
(informative)

Examples and principles of pneumatic press and power interlocking

Figures C.1, C.2 and C.3 show the guard interlocking device positively linked with the valve to control directly the flow of fluid to and from the cylinder.



Key

1 guard opened
2 guard closed
3 hazardous zone

Figure C.1 — Example of power interlocking
No restraint device against a failure of the power supply is shown

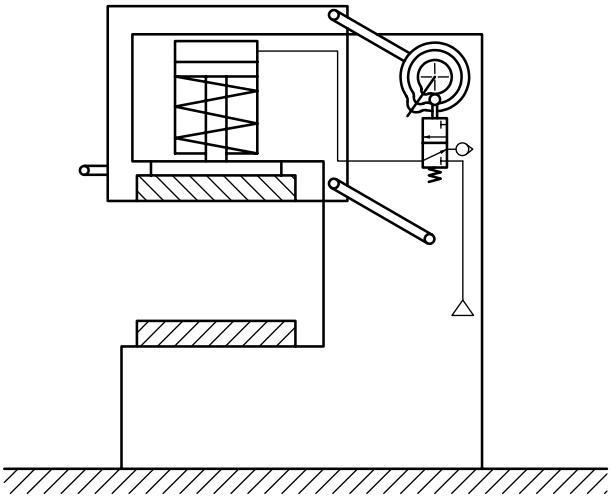


Figure C.2 — Example of power interlocking

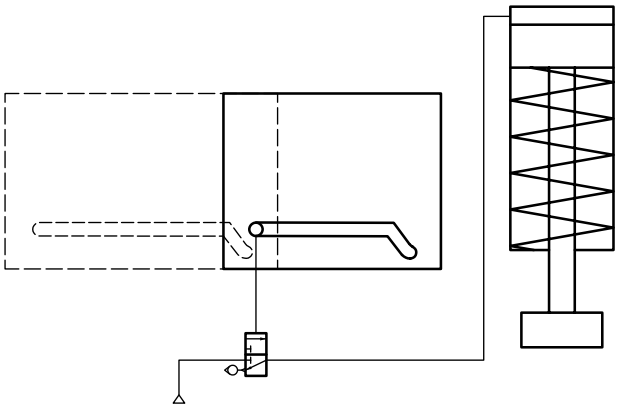


Figure C.3 — Example of power interlocking

Bibliography

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

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

(*Continued from second cover*)

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
ISO 13851 : 2019 Safety of machinery — Two-hand control devices — Principles for design and selection	IS 16817 : 2020/ISO 13851 : 2019 Safety of machinery — Two-hand control devices — Principles for design and selection (*first revision*)	Identical
ISO 16092-1 : 2017 Machine tools safety — Presses — Part 1: General safety requirements	IS 17277 (Part 1) : 2019/ ISO 16092-1 : 2017 Machine tools safety — Presses: Part 1 General safety requirements	Identical

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 'Rules for rounding off numerical values *(second revision)*'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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