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Machine tools safety - Presses - Part 2: Safety requirement for mechanical presses (ISO/DIS 16092-2:2018)

Werkzeugmaschinen Sicherheit - Pressen - Teil 2: Mechanische Pressen (ISO/DIS 16092-2:2018)

Sécurité des machines-outils - Presses - Partie 2 : Exigences de sécurité pour les presses mécaniques (ISO/DIS 16092-2:2018)

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Contents

Page

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 on 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 the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is ISO/TC 39, *Machine tools*, Subcommittee SC 10, *Safety.*

A list of all parts in the ISO 16092 series can be found on the ISO website.

Introduction

This document is a “type C” standard as stated in ISO12100.

It 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 organizations, market surveillance etc.).

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

– 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 in the drafting process 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.

This document is intended to be applied in addition to ISO 16092-1.

Machine tools safety — Presses — Part 2: Safety requirements for mechanical presses

1 Scope

This document, in addition to ISO 16092-1, specifies technical safety requirements and measures to be adopted by persons undertaking the design, manufacture and supply of the following groups of mechanical presses and mechanical press production systems.

Group 1: Presses with a part revolution clutch(es).

Group 2: Presses with a servo drive system. (Mechanical servo presses)

NOTE 1 Requirements in this document are essentially applicable to both groups of the mechanical press. If a requirement applies to only one group then the group is specified.

The presses covered by this document range in size from small high-speed machines with a single operator producing small workpieces to large relatively slow-speed machines with several operators and large complex workpieces.

This document deals with all significant hazards relevant to mechanical presses and ancillary devices (for example, moving die cushions, work-piece ejectors, feeding and transfer systems) which are integral to the machine, when they are used as intended and under the conditions of misuse which are reasonably foreseeable by the manufacturer (see Clause 4). All phases of the machine life cycle as described in ISO 12100:2010, 5.4 have been taken into consideration.

NOTE 2 All significant hazards means those identified or associated with presses at the time of the publication of this document.

This document does not cover machines whose principal designed purpose is described in ISO 16092-1:2017, 1 and machines which

a) transmit energy to impart press motion by using hydraulic or pneumatic means;

b) have two or more slides moving in different angular orientations from each other;

NOTE 3 This document applies to presses which have two or more slides moving in the same angular orientations, for example, a press which has inner and outer slides.

c) utilize a linear motor mechanism(s).

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 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 — General safety requirements*

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

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

IEC 60947-5-8, *Low-voltage switchgear and control gear — Part 5-8: Control circuit devices and switching elements — Three-position enabling switches*

IEC 61800-5-1:2007, *Adjustable speed electrical power drive systems — Part 5-1: Safety requirements — Electrical, thermal and energy*

IEC 61800-5-2:2007, *Adjustable speed electrical power drive systems — Part 5-2: Safety requirements — Functional*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12100, ISO 13849-1, 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 http://www.iso.org/obp

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

3.1
band brake
brake where a flexible band lined with friction material is arranged around the circumference of a drum

3.2
brake
mechanism for slowing, stopping and holding the slide/ram

3.3
mechanical brake
brake using dry or fluid friction

Note to entry: This is also referred to as “friction brake”.

3.4
clutch - part revolution
mechanism which engages or disengages power transmission from the flywheel to the slide at any point in the cycle, for example friction clutches

3.5
electronic handwheel
manually operated control device which initiates and maintains a slide movement by pulse generation input to the servo drive system during its rotation

3.6
monitoring (function)
safety function which ensures that a protective measure is initiated 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 a decrease of the amount of risk reduction is generated

3.7
moving direction monitoring
safety function which monitors the slide moving direction, directly or indirectly

3.8
standstill monitoring
safety function which monitors the slide position, directly or indirectly

3.9
overrun monitoring
safety function which monitors the slide stopping time, angle or braking distance

3.10
servo drive system
system which replaces the need for a clutch by directly connecting a servo motor to the transmission system

3.11
programmed stroke length
length of movement of the slide from the open to the closed position determined by the programmed motion

3.12
protective stop (function)
a stop (function) initiated by a protective measure

3.13
safe energized standstill
safety function preventing an unexpected movement of the slide of more than a defined amount from the stopped position, with energy supplied to the servomotor(s) to resist to external forces, and without actuation of the mechanical brake(s)

3.14
safe de-energized standstill
safety function preventing an unexpected movement of the slide by removing the energy supply to the servomotor(s) and the mechanical brake(s)

3.15
safe stop
a stop (function) initiated by a monitoring function

3.16
safe Torque Off (STO)
function which prevents force-producing power from being provided to the motor

3.17
worst case
condition of the press when it would be under foreseeably unfavourable situations e.g., the press slide has its most disadvantageous position, the maximum of the tool weight is used, etc.

3.18
manual override device
device to operate valve(s) under the condition that the power is lost

3.19
mechanical transmission system
system, which transmits the power of a motor(s) to the slide such as gear (motor reducer), timing belt, crank mechanism, mechanical link, ball screw, harmonic drive reducer, etc.

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 and additional hazards are listed in Annex A, Table A.1.

5 Safety requirements and/or measures

5.1 General

Mechanical 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

ISO 16092-1:2017, 5.2.3 shall apply.

5.2.4 Electric systems

ISO 16092-1:2017, 5.2.4 shall apply.

5.2.5 Mechanical brake

5.2.5.1 The mechanical presses shall be equipped with at least one mechanical brake, which conforms to the requirements from 5.2.5.2 to 5.2.5.5. The mechanical brake and its control system shall be designed

so that, in the event of failure of the pneumatic, hydraulic or electrical supply, the mechanical brake engages immediately.

5.2.5.2 The mechanical brake shall be self–engaging by means of multiple spring assemblies of compression-type and shall require power or force from an external source for disengagement. The mechanical brake shall have sufficient capacity to stop and hold the slide and its attachments at any point in the full stroke range of the press and function when the drive (motor/clutch) is disconnected, even if 50% of the spring assemblies have failed.

5.2.5.3 The mechanical brake(s) shall be designed and constructed to ensure that:

a) all the springs shall be closely uniform in dimension, quality and rating;

b) the means of loading the springs shall be such that, when adjusted, the spring anchorages can be locked to prevent slackening back;

c) the arrangements for spring housing and of guide pins, are such as to minimize binding;

d) any heat generated which may cause a hazardous event is dissipated;

e) effective arrangements are adopted to prevent penetration of lubricants to the brake friction surfaces, when this is not intended by the brake design;

f) any moisture, dust or lubricating oil, which breaks or corrodes packing material (for example, gaskets and seals), cannot influence the required function adversely, for example by obstructing a fluid channel or otherwise affecting its efficiency;

g) the accumulation of dust, fluid or debris is minimized in areas likely to give rise to inefficient brake performance and broken or loose components shall not cause brake fault.

In addition, where the provision is necessary for redundancy and monitoring of the brake control system/function (see Tables 1 and 2), in order to prevent any single fault from leading to the loss of the braking function;

h) all springs shall be well-tried (See ISO 13849-2:2012, Table A.2) and capable of providing the required rationales according to ISO 13849-2:2012, Table A.5 so that any fault which may occur in pressure coil springs is excluded;

i) all mechanical parts or elements shall be capable of providing the required rationales according to ISO 13849-2:2012, Table A.4 so that any fault which may occur in mechanical elements is excluded;

j) the engagement and disengagement of the brake shall not affect its safe function;

k) the brake shall be designed so that failure of a component (e.g. for power transmission or screws) do not stress other components in such a way that rapid consequential dangerous failure is possible.

5.2.5.4 Band brake shall not be used as a mechanical brake for this purpose of stopping the slide.

5.2.5.5 For Group 2 presses,

— the brake shall always be engaged when the servomotor is de-energized; and

— if the brake(s) is designed only for holding the press slide and its attachments (e.g. tool) at any point in the cycle with the drive motor de-energized, the brake(s) shall be capable of a holding torque at least twice the torque which is generated by the mass of the press slide and its attachments in the worst case.

5.2.6 Slide adjustment and stroke adjustment

5.2.6.1 Means that is capable of supervisory control shall be provided to prevent the press from cycling while the slide adjust circuit is enabled and to prevent operating the slide adjust motor while the servo motor is energized for Group 2 presses or the clutch control circuit is energized for Group 1 presses. This requirement shall not apply when the slide adjustment motor is operable in presses with automatic cycle and programmable control systems that compensate, for e.g. tool wear during press operation.

5.2.6.2 The means of controlling the slide adjustment shall be clearly identified.

5.2.6.3 The up and down travel of the slide adjustment shall be limited; e.g. by limit switches, proximity switches or encoders.

5.2.7 Slide counterbalance systems

5.2.7.1 If provided, mechanical spring counterbalance systems shall incorporate means to retain system parts in the event of breakage and shall have the capability of holding the slide and its attachments at mid-stroke without the brake applied.

5.2.7.2 If provided, air counterbalance cylinders shall incorporate means to retain the piston and rod in case of breakage or loosening and shall have the capability of holding the slide and its attachments at any point in the cycle without the brake applied.

5.2.8 Operating valves and exhaust systems

5.2.8.1 Operating valves and exhaust systems used with fluid valves for mechanical brake(s), clutch(s) or combined clutch/brake unit(s) shall be designed to prevent deterioration of stopping performance in the event of failure.

5.2.8.2 Operating valves shall be designed to ensure that, when in the non-operating position, leakage past the inlet valve will escape sufficiently to prevent the build-up of pressure in mechanical brake(s), clutch(s) or combined clutch/brake unit(s) operating cylinder.

5.2.8.3 Exhaust ports, piping between mechanical brake(s), clutch(s) or combined clutch/brake unit(s), operating cylinders and valves, and exhaust systems used with clutch fluid valves shall be designed to prevent the deterioration of stopping performance of the press. Precautions shall be taken to ensure that the exhaust ports of operating valves are of adequate size to prevent residual pressure in the cylinder. The valve shall be selected so that the pressure ratio between the mechanical brake(s), clutch(s) or combined clutch/brake unit(s) is such that the residual pressure in the cylinder will not become excessive in the event of a valve fault.

NOTE Normally, a ratio of at least 3.5 to 1 between the spring pressure in the brake and the residual pressure in the cylinder is satisfactory.

5.2.8.4 Manual override devices incorporated into operating valves shall be designed to include a captive lid or cover which requires the use of a tool or key to open it. Electrical manual override devices shall be key-operated and their operation shall only be possible with the slide in BDC position, the motor off, and the flywheel stopped as long as they are provided.

5.2.9 Additional requirements for Group 1 presses

The engagement and disengagement of the part revolution clutch (friction clutch) and the mechanical brake shall not affect their safety function.

NOTE Combined clutch and brake units are recommended in order to reduce the possibility of overlapping engagement.

The clutch and its control system shall be designed so that, in the event of the failure of a pneumatic, hydraulic or electrical supply, the clutch is disengaged immediately.

The clutch shall be designed and constructed to ensure that:

a) any moisture, dust or lubricating oil, which breaks or corrodes packing material (e.g. gaskets and seals), cannot influence the required function adversely, for example by obstructing a fluid channel or otherwise affecting their efficiency;

b) any heat generated which can cause a hazard is dissipated. Clutches shall be of a capacity capable of engaging and disengaging the stroke in the correct position, without excessive temperature rise, under conditions of maximum use of the clutch;

c) sufficient working clearances are provided to ensure that, the clutch will disengage upon removal of the external engaging force;

d) arrangements are made to prevent the accumulation of, and for the effective dispersal, debris evolved from friction surfaces in places where it can degrade (decrease) clutch performance.;

e) the clutch is disengaged when the external clutch–engaging means is removed, deactivated, or de–energized;

f) if diaphragms are used in a clutch system, measures shall be taken to avoid damage by the cutting effect of sharp edges or wearing by rough surfaces. Evacuation of fluid shall not be prevented due to slackening of the diaphragm, e.g. due to material fatigue.

5.2.10 Additional requirements for Group 2 presses

5.2.10.1 Where a safety relevant belt drive mechanism is utilized to transmit force or torque to decelerate or hold the slide, any single fault of the belt drive such as belt breakage, belt elongation, unfastening, looseness, belt pulley idling, tooth skipping, shall not lead to the loss of the braking function. If a fault, which would affect the stopping performance occurs, it shall be detected immediately, then the safe stop stated in 5.4.1.2.4 shall be initiated. No new cycle initiation shall be possible until the fault is eliminated.

5.2.10.2 Where Group 2 presses are capable of converting the kinetic energy of the slide into electrical energy and storing the electrical energy in devices e.g. capacitors, unintended slide movement resulting from electrical discharges from the devices shall be prevented.

5.3 Mechanical hazards in the tools area

5.3.1 Major danger zone

ISO 16092-1:2017, 5.3.1 shall apply.