INTERNATIONAL STANDARD

ISO 23582-1

First edition
2023-03

Plastics and rubber machines — Clamping systems —

Part 1: Safety requirements for magnetic clamping systems

Machines pour les matières plastiques et le caoutchouc — Systèmes de bridage —

Partie 1: Prescriptions de sécurité pour les systèmes de bridage magnétique

Reference number
ISO 23582-1:2023(E)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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 270, *Plastics and rubber machines,* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 145, *Plastics and rubber machines,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

A list of all parts in the ISO 23582 series can be found on the ISO website.

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

This document has been created in recognition of the particular hazards that are presented by magnetic clamping systems when integrated and installed in a plastics or rubber machine.

Hazards are frequently unique to a particular magnetic clamping system integrated in a plastics or rubber machine. The number and types of hazards are directly related to the nature of the application, the automation process and the complexity of the installation.

The risks associated with these hazards vary with the type of application and production process.

For the purpose of understanding requirements in this document, a word syntax is used to distinguish absolute requirements from recommended practices or suggested actions. The word "shall" is used to identify requirements necessary for conformance with this document. Such requirements are to be accomplished unless an alternative instruction is provided, or a suitable alternative is determined by a risk assessment. The word "should" is used to identify suggestions, recommended actions or possible solutions for requirements, but alternatives are possible and the suggested actions are not absolute.

In recognition of the variable nature of hazards with the application of magnetic clamping system integrated in a plastics or rubber machine, this document provides guidance for the assurance of safety in the design of magnetic clamping systems. Since safety in the use of magnetic clamping systems is influenced by the integration in the machine and by the design and use of the different moulds, a supplementary, though equally important, purpose is to provide guidelines for the integration, the installation and the use of magnetic clamping systems.

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 organizations, 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.

Plastics and rubber machines — Clamping systems —

Part 1:
Safety requirements for magnetic clamping systems

1 Scope

This document specifies the essential safety requirements for the design, the construction and the integration of magnetic clamping systems (MCS) for plastics and rubber machines (e.g. injection moulding machines, compression moulding machines) and provides operational limits and information for their safe use.

This document deals with the basic hazards, hazardous situations or hazardous events that are listed in Annex A, when an MCS is used utilizing magnetic force to affix a mould to the platen of a machine in which it is integrated, and provides requirements to eliminate or adequately reduce the risks associated with these hazards taking into consideration conditions of misuse that are reasonably foreseeable by the manufacturer.

This document also specifies requirements for the MCS when integrated into a machine. This document does not deal specifically with hazards associated with production processes or other processes (e.g. horizontal or vertical injection moulding processes). Other standards can be applicable to these process hazards.

This document does not cover hydraulic, pneumatic or mechanical clamping systems.

This document is not applicable to MCS manufactured before the date of its publication.

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

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

IEC 62061, *Safety of machinery — Functional safety of safety-related control systems*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12100:2010 and the following apply.

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

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

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

3.1
magnetic clamping system
MCS
combination of one or more *magnetic plates* (3.3) and a *magnetic clamping control system* (3.2)

3.2
magnetic clamping control system
system to control and monitor the status of the *magnetic plate(s)* (3.3)

3.3
magnetic plate
plate composed of ferromagnetic material including coils, magnets and sensors

3.4
magnetic clamping system force
force retaining the mould installed on the *magnetic plate* (3.3)

3.5
ejector force
maximum ejector(s) force applied to the installed mould

3.6
nozzle force
force of the nozzle against the fixed side of the installed mould

Note 1 to entry: This force is relevant only when the mould is open or while opening or closing.

3.7
magnetic saturation
state reached when an increase in external magnetic field does not increase the magnetization of the plate further

3.8
machine
plastics and rubber machine where the *magnetic clamping system* (3.1) is integrated

3.9
mould change mode
selectable mode of operation of the *machine* (3.8) that allows individual motions at a low speed, low pressure and low force, used for changing the mould

3.10
MCS special mode
mode where the *magnetic clamping system* (3.1) enables machine movements to recover from an MCS alarm, this mode is only available when the *machine* (3.8) is in *mould change mode* (3.9) and the MCS in alarm

3.11
fully automatic machine
machine (3.8) that completes its working cycle without the intervention of an operator between the machine platens

3.12
integration
act of combining a *magnetic clamping system* (3.1) with plastics and rubber *machines* (3.8) to form a machine system capable of performing useful work such as production of parts

Note 1 to entry: This act of machine building can include the requirements for the installation of the system.

3.13
MCS enable signal
interlock signal from the machine to the *magnetic clamping system* (3.1) to allow magnetizing and demagnetizing

4 Safety requirements and/or protective/risk reduction measures

4.1 General

The MCS shall conform with the safety requirements and/or protective/risk reduction measures of this clause. In addition, it shall be designed in accordance with the principles of ISO 12100:2010 for relevant but not significant hazards, which are not dealt with by this document.

The safety related parts of the control systems shall be in accordance with the required performance levels PL_r in accordance with ISO 13849-1 or SIL in accordance with IEC 62061, as specified in the relevant subclauses.

4.2 Magnets

Only magnets that ensure the mould is held without power after magnetization shall be used.

4.3 Magnetic plate(s)

Magnetic plate(s) shall be marked to identify which machine platen they affect. At least two separate actions shall be required for magnetization/demagnetization; the actuators used to effect magnetization/demagnetization shall clearly identify which magnetic plates they affect. A visual indicator shall display the magnetic status of the magnetic plate when the MCS is under power.

4.4 Magnetizing/demagnetizing current

The MCS control for switch off the current of magnetization and demagnetization shall be designed to achieve PL_r=e with MCS enable signals coming from the machine control system.

4.5 Magnetic clamping control system

4.5.1 Magnetic clamping control system detection requirements

The control circuit of the MCS shall detect each of the following conditions:

— the contact of the mould base on the magnetic plate in accordance with PL_r = b or SIL=1;

— the magnetic state of the magnetic plate in accordance with PL_r = d or SIL=2;

— the overtemperature of the magnetic plate in accordance with PL_r = b or SIL=1.

Sensors to detect the presence of the mould shall be monitored during every mould change. If a change of state of sensors is not detected during mould change, magnetization shall be prevented.

The PL_r or SIL for each signal provided to the machine control circuit shall be the same as the detection circuit or a single signal can be provided in accordance with PL_r=d or SIL=2. See 6.1.4.

4.5.2 Magnetic clamping control system magnetizing/demagnetizing

The control circuit of the MCS shall allow magnetization or demagnetization only when the MCS receives MCS enable signals and mould change mode signal from the machine.

The MCS enable signal coming from the protective devices to detect the presence of a human body part or whole body in the mould area shall comply with PL_r=d or SIL=2 for fully automatic machines or, for all other machines, PL_r=e or SIL=3.

The mould change mode signal coming from the machine control system shall comply with PL_r=b or SIL=1.

The control circuit of the MCS shall allow magnetization in accordance with PL_r=b or SIL=1 when the contact of the mould base on the plate is detected.

4.5.3 Magnetic clamping control system enabling machine movements

The control circuit of the MCS shall provide signals to enable machine movements when:

— no overtemperature of the magnetic plate is detected and each plate verifies one of the following conditions:

  — plate is magnetized and have reached magnetic saturation, and a mould is detected,

  — plate is demagnetized and, either a mould is not detected, or machine is in mould change mode; or

— the machine is in mould change mode and the MCS is in MCS special mode after an alarm detection. The MCS shall provide an information to the user that the MCS special mode is active, for example an indicator on the MCS control panel. The control circuit of MCS special mode shall be in accordance to PL_r=d and a maintained action on a specific actuator shall be necessary to activate this MCS special mode.

See 6.1.3.

When the MCS is switched off no enabling signals shall be given to the machine.

4.6 Magnetic clamping system force

4.6.1 General

The magnetic clamping system force may vary depending on the mould that is installed.

The magnetic clamping system force shall be sufficient to hold the mould half on each platen, considering all forces, accelerations due to movements and their moments applied to the mould half. See 6.1.2 and 6.2.

4.6.2 Magnetic clamping system force when the MCS is integrated in horizontal machines

For the movable and fixed platen with a magnetic plate, the magnetic clamping system force of each magnetic plate shall be at least the highest of the following values:

1) 6,5 times of the weight of each mould half;

2) 3,5 times of the weight of the complete mould;

3) 3,0 times of the mould half weight multiplied for the ratio between the horizontal and vertical extension of the mould half (see Annex B).

4.6.3 Magnetic clamping system force when the MCS is integrated in vertical machines

For the upper platen with a magnetic plate, the magnetic clamping system force shall be at least the highest of the following values:

1) 6,5 times of the weight of the upper mould half; or

2) 3,5 times of the weight of the complete mould.

For the lower platen with a magnetic plate, the magnetic clamping system force shall be at least 3 times of the weight of the lower mould half.

4.7 Electrical hazards and hazards due to electromagnetic interference

4.7.1 General

The electrical equipment of the MCS shall be in accordance with the relevant requirements of IEC 60204-1:2016.

NOTE See the Foreword of IEC 60204-1:2016 for differing practices in some countries.

In particular, the requirements of 4.7.2 to 4.7.5 shall be satisfied.

4.7.2 Basic protection

Protection against direct contact shall be in accordance with IEC 60204-1:2016, 6.2.

4.7.3 Fault protection

Protection against indirect contact shall be in accordance with IEC 60204-1:2016, 6.3.

4.7.4 Protection against ingress of solids and liquids

Electrical equipment shall have enclosures affording protection in accordance with IEC 60204-1:2016, 11.3.

4.7.5 Protection against electromagnetic interference

The electrical circuit of the MCS shall have a sufficient level of immunity to electromagnetic disturbances so it can function in its environment. During installation of electrical and electronic components, the MCS manufacturer shall follow the wiring recommendations for installation and use provided by the component manufacturer.

5 Verification of safety requirements and/or protective/risk reduction measures

Type tests shall be used to verify the safety requirements and/or protective measures in accordance with Table 1.

Table 1 — Verification methods and documentation

Subclause	Item	Verification methods			
		Visual inspection	Functional test	Measurement	Calculation
4.1	Safety related parts of the control systems		X		X
4.2	Magnets		X		
4.3	Magnetic plates	X	X		
4.4	Magnetizing/ demagnetizing current		X		X

Table 1 *(continued)*

Subclause	Item	Verification methods			
		Visual inspection	Functional test	Measurement	Calculation
4.5.1	MCS detection requirements		X		X
4.5.2	MCS magnetizing/ demagnetizing		X		X
4.5.3	MCS enabling machine movements	X	X		X
4.6.1, 4.6.2, 4.6.3	Magnetic clamping force				X
4.7	Electrical equipment	X	X	X	X

6 Information for the integration and the use of the MCS

6.1 Instruction for the integration of the MCS in a plastics and rubber machine

6.1.1 General

Each MCS shall be accompanied by an instruction handbook giving general instructions for integration and use (ISO 12100:2010, 6.4.5) as well as the following information.

The MCS handbook shall give specific instruction for the integration of the MCS in a plastics and rubber machine, as follows:

— the installation requirements of the MCS;

— the magnetic clamping system shall be put into operation by qualified personnel;

— the MCS may only be integrated into a machine capable of accepting this system. The MCS should not prevent a clear view of any hazardous zone of the machine where the MCS is integrated, nor prevent access to the working positions specified in the instruction handbook of the machine;

— a verification procedure shall be performed to verify, by visual inspection, the proper separation of the mould halves after magnetization/demagnetization;

— if a label showing the method of calculation of magnetic clamping system force is required, then it shall be affixed on the machine platen beside the magnetic plate (see Clause 7).

6.1.2 Forces acting against the magnetic clamping system force

The following requirements shall be considered when the mould is open or while opening or closing:

— any combination of forces acting in a perpendicular direction to the magnetic surface that work against the magnetic clamping system force should be lower than 90 % of the magnetic clamping system force;

— any combination of forces acting in a parallel direction to the magnetic surface should be lower than 18 % of the magnetic clamping system force minus any combination of forces acting in a perpendicular direction to the magnetic surface and that work against the magnetic clamping system force, or a mechanical support or locating preventing displacement should be installed;

— any combination of moments due to any combination of forces acting to rotate the mould should be lower than 33 % of the moment generated by the magnetic clamping system force.

When a movable interlocking guard or a protective device giving access to the mould area is open or activated, only forces not acting against the magnetic clamping system force shall be applied to the mould. If this is not practical or feasible, a warning sign regarding possible mould detachment shall be fixed in the mould area.

6.1.3 Machine movements

Machine movements shall be allowed only when the enable signal from the MCS is present; if the MCS special mode is active, safe procedures shall be adopted.

6.1.4 Signals from the machine to the MCS

Magnetization/demagnetization is only possible if a human body or body part(s) are not detected in the mould area. Magnetization/demagnetization is only possible when the safeguarding devices of the mould area are activated.

Any other machine device may deactivate the MCS enable signal, depending on the characteristics and risk analysis of the machine.

6.2 Instruction for the use of an MCS in a plastics and rubber machine

Each MCS shall be accompanied by an instruction handbook giving the following specific instructions for use:

— the safe procedure for mould clamping/unclamping;

— the mould change procedure(s), including the verification of proper clamping and unclamping;

— the maximum weight, and maximum and minimum dimensions of each mould half and mould;

— the required minimum contact area of the mould base, considering non-contact surfaces;

— the required conditions of contact surfaces;

— the mould and/or base plate requirements;

— the machine platen requirements;

— the base plate material requirements;

— the mould and/or base plate flatness and parallelism tolerances;

— the mould and/or base plate roughness;

— the minimum base plate thickness;

— the method to calculate the magnetic clamping system force and an example of calculation for a given mould;

— the maximum permissible temperature for the magnetic plates;

— the requirements to adjust the ejector stroke and the alignment to prevent the over stroking;

— the recommended maintenance schedule of the MCS;

— the performance level for safety-related outputs of the MCS;

— the recommendations for documenting safe work procedure with reference to the alarms of the MCS (e.g. detachment of the mould, overtemperature) before the operator enters the mould area;

— the procedure to reach a safe state of the MCS before the operator enters the mould area with reference to the function of the emergency stop of the machine, especially if this can interrupt the magnetization and demagnetization and, as a result, the MCS is in an undefined state;

— the limitation of use for persons wearing medical device;

— the recommendation that the magnetic clamping system force shall prevent the half mould to rotate off the platen under its own weight (cantilever effect). A method shall be indicated to make sure that for both, the movable and the fixed platen with a magnetic plate, the moment of the magnetic clamping system force is at least 300 % (3 times) the moment of the half mould weight (see Annex B).

The following requirements shall be considered when the mould is open, or while opening or closing:

— any combination of forces acting in a perpendicular direction to the magnetic surface that work against the magnetic clamping system force should be lower than 90 % of the magnetic clamping system force;

— any combination of forces acting in a parallel direction to the magnetic surface should be lower than 18 % of the magnetic clamping system force minus any combination of forces acting in a perpendicular direction to the magnetic surface and that work against the magnetic clamping system force, or a mechanical guiding system preventing displacement should be installed;

— any combination of moments due to any combination of forces acting to rotate the mould should be lower than 33 % of the moment generated by the magnetic clamping system force.

When a movable interlocking guard or a protective device giving access to the mould area is open or activated, only forces not acting against the magnetic clamping system force shall be applied to the mould. If this is not practical or feasible, a warning sign regarding possible mould detachment shall be fixed in the mould area.

7 Marking

The minimum markings for the MCS shall include:

— designation of the MCS;

— name and address of the manufacturer and supplier;

— business name and full address of the authorized representative (where applicable);

— designation of series or type;

— serial number if any, or MCS number;

— year of construction;

— mandatory marking if any.

— pictogram to prohibit access close to MCS for persons wearing medical devices.

If the magnetic clamping system force is not displayed on the interface panel, then a label showing the method of calculation of magnetic clamping system force shall be supplied with the MCS.

A warning sign regarding possible mould detachment shall be supplied with the MCS.