International Standard

ISO 23063

Foundry machinery — Safety requirements for high pressure die casting machines

Machines de fonderie — Exigences de sécurité pour les machines à couler sous haute pression

First edition
2024-11

Reference number
ISO 23063:2024(en)

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Published in Switzerland

Contents

Page

Foreword

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This document was prepared by Technical Committee ISO/TC 306, *Foundry machinery*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 202, *Foundry machinery,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

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 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 (e.g. regulators, accident prevention organisations, market surveillance).

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, for example, 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.

Where, for clarity, an example of a preventive measure is given in this document, this should not be considered as the only possible solution. Any other solution leading to the same risk reduction is permissible if an equivalent level of safety is achieved.

It is assumed that the machinery according to the scope is operated and maintained by trained personnel.

Foundry machinery — Safety requirements for high pressure die casting machines

1 Scope

This document applies to high pressure die casting machines:

a) hot-chamber die casting machines (horizontal die closing system);

b) horizontal cold-chamber die casting machines (horizontal die closing system).

This document applies to high pressure die casting units, i.e. high pressure die casting machines (HPDCM), and their interfaces with the following ancillary equipment:

a) die;

b) melting, holding and dosing furnaces (see ISO 13577-1:2016);

c) metal feeding equipment;

d) inserting and removal devices;

e) spraying appliances;

f) heating and cooling devices for the die.

This ancillary equipment itself is not covered.

Additional risks arising from the material being cast are not covered.

This document does not apply to either low pressure die casting machines or gravity die casting machines, or both.

This document deals with all significant hazards, hazardous situations and events relevant to pressure die casting machines when used as intended and under conditions of misuse which are reasonably foreseeable by the manufacturer (see Clause 4).

This includes hazards coming from intentional interactions as well as unintentional but foreseeable interactions between movable parts of the machine and persons.

This document provides the requirements to be met by the manufacturer to ensure the safety of persons and property during transport, commissioning, use, de-commissioning and maintenance periods, as well as in the event of foreseeable failures or malfunctions that can occur in the equipment.

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 3864-1:2011, *Graphical symbols — Safety colours and safety signs — Part 1: Design principles for safety signs and safety markings*

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

ISO 4414:2010, *Pneumatic fluid power — General rules and safety requirements for systems and their components*

ISO 7000:2019, *Graphical symbols for use on equipment — Registered symbols*

ISO 7731:2003, *Ergonomics — Danger signals for public and work areas — Auditory danger signals*

ISO 7745:2024, *Hydraulic fluid power — Fire-resistant fluids — Requirements and guidelines for use*

ISO 11201:2010, *Acoustics — Noise emitted by machinery and equipment — Determination of emission sound pressure levels at a work station and at other specified positions in an essentially free field over a reflecting plane with negligible environmental corrections*

ISO 11202:2010, *Acoustics — Noise emitted by machinery and equipment — Determination of emission sound pressure levels at a work station and at other specified positions applying approximate environmental corrections*

ISO 11204:2010, *Acoustics — Noise emitted by machinery and equipment — Determination of emission sound pressure levels at a work station and at other specified positions applying accurate environmental corrections*

ISO 11429:1996, *Ergonomics — System of auditory and visual danger and information signals*

ISO/TR 11688-1:1995, *Acoustics — Recommended practice for the design of low-noise machinery and equipment — Part 1: Planning*

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

ISO 13732-1:2006, *Ergonomics of the thermal environment — Methods for the assessment of human responses to contact with surfaces — Part 1: Hot surfaces*

ISO 13849-1:2023, *Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design*

ISO 13850:2015, *Safety of machinery — Emergency stop function — Principles for design*

ISO 13851:2019, *Safety of machinery — Two-hand control devices — Principles for design and selection*

ISO 13854:2017, *Safety of machinery — Minimum gaps to avoid crushing of parts of the human body*

ISO 13855:2010, *Safety of machinery — Positioning of safeguards with respect to the approach speeds of parts of the human body*

ISO 13856-2:2013, *Safety of machinery — Pressure-sensitive protective devices — Part 2: General principles for design and testing of pressure-sensitive edges and pressure-sensitive bars*

ISO 13857:2019, *Safety of machinery — Safety distances to prevent hazard zones being reached by upper and lower limbs*

ISO 14119:2024, *Safety of machinery — Interlocking devices associated with guards — Principles for design and selection*

ISO 14120:2015, *Safety of machinery — Guards — General requirements for the design and construction of fixed and movable guards*

ISO 14122-1:2016, *Safety of machinery — Permanent means of access to machinery — Part 1: Choice of fixed means and general requirements of access*

ISO 14122-2:2016, *Safety of machinery — Permanent means of access to machinery — Part 2: Working platforms and walkways*

ISO 14122-3:2016, *Safety of machinery — Permanent means of access to machinery — Part 3: Stairs, stepladders and guard-rails*

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

IEC 61310-1:2007, *Safety of machinery — Indication, marking and actuation — Part 1: Requirements for visual, acoustic and tactile signals*

IEC 61310-2:2007, *Safety of machinery — Indication, marking and actuation — Part 2: Requirements for marking*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12100 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
casting
component or product that has obtained its shape through the process of *die casting* (3.2)

3.2
die casting
process in which molten *metal* (3.7) is injected into a die and held under pressure until complete solidification

3.3
die casting machine
machine with the purpose to inject molten *metal* (3.7) under pressure into a parted die which is connected to the platens of the machine

3.4
die casting cell
die casting machine (3.3), together with auxiliary and *ancillary equipment* (3.6), which form a complete production unit

3.5
auxiliary equipment
set of all the devices which carry out additional process functions within a *die casting cell* (3.4)

3.6
ancillary equipment
devices which automatically carry out process functions additional to those of the *die casting machine* (3.3) itself, e.g. feeding the *metal* (3.7), removing the castings, spraying the die

3.7
metal
material, which is suitable for being cast in the *die casting* (3.2) process

3.8
hot-chamber die casting machine
die casting machine (3.3) with an inclined or horizontal *die closing system* (3.10) having the *shot sleeve* (3.19) and *plunger* (3.20) which are submerged in the molten *metal* (3.7) of the furnace

Note 1 to entry: See Figure A.1.

3.9
cold-chamber die casting machine
die casting machine (3.3) with a horizontal *die closing system* (3.10), where molten *metal* (3.7) is delivered to the *shot sleeve* (3.19) in measured amounts from a separate furnace

Note 1 to entry: There are cold-chamber die casting machines with toggle (see Figure A.2) and toggle-free (see Figure A.3) closing systems.

3.10
die closing system
assembly which opens and closes the die, and holds the die against the force exerted on the molten *metal* (3.7) during injection and solidification

3.11
injection system
assembly which forces molten *metal* (3.7) from the *shot sleeve* (3.19) into the die cavity and applies pressure to the molten metal during solidification

3.12
ejector
system of assembled machine components (e.g. ejector plate and ejector rod) connected to the ejector device of the die, which allows the ejection of castings from the die cavity

3.13
core puller
assembly which controls movements of cores

3.14
tie bar pulling device
device for pulling *tie bars* (3.17) in order to facilitate die set-up procedure

3.15
die clamping device
device for clamping the die to the platens of the machine (automatically or manually)

3.16
moving platen
movable platen
platen to which the moving die-half is connected

3.17
tie bar
bar which carries the locking load and guide the *moving platen* (3.16)

3.18
injection drive
system (e.g. hydraulic) which moves the *plunger* (3.20) and applies force to it

3.19
shot sleeve
cylindrical container of a *cold-chamber die casting machine* (3.9) in which pressure is applied to molten *metal* (3.7)

3.20
plunger
plunger tip
piston which forces molten *metal* (3.7) from the *shot sleeve* (3.19) into the die and applies pressure to the molten metal during solidification

3.21
gooseneck
part of an *injection system* (3.11) [containing the *shot sleeve* (3.19) and *metal* (3.7) flow channel] which is submerged in molten metal

Note 1 to entry: Only applies to *hot-chamber die casting machines* (3.8).

3.22
nozzle
connection between the *gooseneck* (3.21) and the fixed die-half

3.23
biscuit
slug
metal (3.7) surplus which solidifies in the cold-chamber *shot sleeve* (3.19) and is ejected with the casting

3.24
fixed platen
platen to which the fixed die-half and the *metal* (3.7) *injection system* (3.11) are connected

3.25
die area
area between the *fixed platen* (3.24) and the *moving platen* (3.16)

3.26
cylinder platen
platen to which the die closing mechanism and the closing cylinder are connected

Note 1 to entry: Also known as thrust platen, reaction platen, link housing or rear platen.

3.27
die closing mechanism area
area between the *moving platen* (3.16) and the *cylinder platen* (3.26)

3.28
injection drive area
area between the *fixed platen* (3.24) and the shot cylinder

3.29
closing safety device
device actuated by the movable guard which prevents the die from closing if a failure occurs in the control system

3.30
setting mode
operating mode where any step in the process can be selected and hand operated in any sequence with restricted operation of the safety functions

EXAMPLE To perform individual steps of the process (not necessarily in operating cycle sequence), like changing a die.

3.31
manual mode
operating mode where the individual steps in the machine cycle are hand initiated

EXAMPLE To perform the individual steps of the process (only in the sequence which is fixed by the program), such as to finish the casting cycle or to run the casting cycle in order to examine or to look for faults.

3.32
semi-automatic mode
operating mode where each cycle is hand initiated but thereafter automatically proceeds to completion

EXAMPLE To produce castings in which at least one of the steps of the process which is performed outside the machine is executed by the *operator* (3.35).

3.33
automatic mode
operating mode where the completion of a casting cycle initiates the next casting cycle

EXAMPLE To continuously produce castings with any external process steps being automatically carried out by ancillary device.

3.34
machine-setter
designated person, trained and skilled to carry out adjusting, die changing, setting and starting-up the *die casting* (3.2) process

3.35
operator
designated person trained and skilled to run the *die casting machine* (3.3)

3.36
access door
door of the distance guards of a *die casting cell* (3.4)

3.37
inspection
measure to observe and assess the current condition as well as fault finding

Note 1 to entry: Measures (e.g. measuring, testing, diagnostics) including the determination of the causes of wear or damage and the derivation of the necessary consequences for the continued use.

Note 2 to entry: This definition does not cover “material inspection”.

3.38
maintenance
combination of service, *inspection* (3.37), reconditioning and functional test of the equipment

Note 1 to entry: The purpose is to preserve the working condition or returning to this condition so that the required function can be performed (including safety requirements).

Note 2 to entry: Service is a measure to maintain the nominal condition. The nominal condition can be maintained in general without dismantling/disassembling major parts of the equipment (e.g. cleaning, lubrication of the work equipment as well as addition or replacement of agents) or by replacing tools or operational changing parts.

Note 3 to entry: Reconditioning is a measure to return to the nominal condition. Foreseeable measures to replace worn parts or parts having expired the foreseen lifetime (can require dismantling/disassembling). These parts should meet manufacturers' specification.

Note 4 to entry: A functional test is checking the functionality of the exchanged or repaired parts. Adjustment work can be required (e.g. test runs, verifying safety functions).

3.39
dry cycle
operation mode of the *die casting machine* (3.3), with all movements of the die casting machine, which are typical for a production cycle [e.g. with injection cylinder movements but without molten *metal* (3.7) and with die opening, die closing and interlocking using a die or a *test block* (3.40) mounted in the *die area* (3.25)]

3.40
test block
object for simulating the presence of a die in the *die area* (3.25) of the machine

3.41
performance level
PL
discrete level used to specify the ability of safety-related parts of control systems to perform a safety function under foreseeable conditions

Note 1 to entry: The symbols “a”, “b”, “c”, “d”, and “e” in this document indicate the performance level of safety-related components with respect to their average probability of dangerous failure. More information on these symbols is given in ISO 13849-1.

[SOURCE: ISO 13849-1:2023, 3.1.5, modified — Note 1 to entry has been replaced.]

4 List of significant hazards

4.1 General

Clause 4 contains all the significant hazards, hazardous situations and events, as far as they are dealt with in this document, identified by risk assessment as significant for this type of machinery and which require action to eliminate or reduce the risk.

If, because of the special design of either a die casting machine or its ancillary equipment, or both, additional hazards can exist, then an additional risk assessment shall be made.

4.2 Mechanical hazards

Mechanical hazards at die casting machines and at their ancillary equipment can occur because of the design and construction of the machine (e.g. risk of stumbling and striking) and because of dangerous movements (e.g. crushing, shearing).

Dangerous movements include movement of the following:

a) die;

b) core pullers;

c) ejectors;

d) ancillary equipment;

e) injection system;

f) power operated guards;

g) die closing system;

h) die clamping device;

i) tie bar pulling devices.

Some principal examples of mechanical hazards and danger zones are shown in Figure A.4.

The bursting of reservoirs, pipelines and flexible hoses containing pressurized fluids can cause hazards, e.g. whipping of hoses.

4.3 Electrical and control system hazards

4.3.1 Electrical hazards

Electrical hazards at die casting machines can occur, for example, by:

— electrical contact, direct or indirect;

— external influences on electrical equipment;

— damage of electrical components by thermal radiation or other phenomena (e.g. projection or leaking of molten metal particles).

4.3.2 Control system hazards

Failures which cause unexpected machine movements can occur in either the electric/electronic, hydraulic or pneumatic control system, or both.

4.4 Thermal hazards

Thermal hazards which can occur at die casting machines by:

a) flashing, splashing or flowing out of molten metal, for example:
   - out of the parting-line of the die (see Figures A.5 and A.6);
   - between shot sleeve and plunger (see Figures A.5);
   - between nozzle and die (see Figure A.6);

b) bursting of biscuits;

c) contact with structural components of the machine which are being heated during the process;

d) contact with ancillary equipment which are used to heat the working substances or dies;

e) release of hot operating fluids;

f) heat from furnaces.

4.5 Fire hazards

Fire hazards result from the presence of a combination of molten metal, heating devices, hot surfaces and combustible materials (e.g. flammable greases, flammable hydraulic fluids and pressurized combustible release agents) in case of a line breakage.

4.6 Noise hazards

Noise hazards can be caused by the operation of the high pressure die casting machine and/or the intended die casting process.

Sources of noise at high pressure die casting machines are, for example:

- the casting process;
- the moving parts of the machinery and their power sources;
- the manner in which the machine has been installed.

4.7 Hazards caused by gases, vapours, fumes and dusts

Hazards caused by dangerous gases, vapours, fumes and dust can occur at die casting machines, for example:

- by use of lubricants;
- by use of release agents;
- by fumes, vapours and dust given off when melting and holding molten metal (e.g. lead alloys);
- during cleaning.

Risk of explosion is not present as they are all diffused emissions and generation of explosive gaseous emissions is technological not possible.

4.8 Hazards generated by neglecting ergonomic principles in machinery design

Health can be impaired by neglecting ergonomic principles. Possible causes of injury are:

a) incorrect lifting of heavy loads due to the design of the machine, for example during:
   - setting up the die casting machine;